Reliance
Industries Limited

J3 PROGRAM

JAMNAGAR, INDIA

Basic Engineering Design Data

10080-1-DBD-GE-001

1	20.06.12.	Issued for Licensor KO	SM	SM / SG	DLG	JV
Rev	Date	Revision Details	Prepared By	Checked By	PMT	RIL
					Approved By	

Holds

SECTION	ITEM	ACTION BY
General	Environmental Design Guidelines	Reliance
General	Reliance Design requirements related to Process and Systems design	PMT
General	Specific guidelines related to Reliance CHSEE practices	PMT
Project procedures	Additional project procedures not covered under above 2 categories	PMT
Sections 8.10, 8.11, 8.15	Fuel gas system definition Syngas system definition Nitrogen system definition	Licensor inputs + + OSBL designer inputs

Reliance Industries Limited

Table of Contents

1 PURPOSE 8

2 SCOPE 8

2.1 Project life 8

3 DEFINITIONS 8

4 INTRODUCTION 10

5 CODES, STANDARDS, AND SOFTWARE 11

5.1 Specific codes and standards to be used 11

5.2 Software to be used 12

6 UNITS OF MEASUREMENT (UOM) 14

7 SITE INFORMATION 17

7.1 Site data 17

7.2 Meteorological Data 18

7.2.1 Wind Data 18

7.2.2 Temperatures 18

7.2.3 Rainfall 19

7.2.4 Humidity 19

7.2.5 Atmospheric Pressure: 19

1.1. Seismic Data 19

1.2. Metocean Data 19

7.2.6 Tide Levels 19

7.2.7 Surge Levels 20

7.2.8 Wave Heights 20

7.2.9 Current 21

1.3. Noise Level Limits **21**

7.2.10 Overall sound pressure level 21

7.2.11 Environmental noise standard 21

1.4. Site Access **21**

8 UTILITY INFORMATION **22**

8.1 General **22**

8.2 Utilities distribution **22**

8.3 Sea Water System **22**

8.4 Desalinated Water System **23**

8.5 Cooling water systems **23**

8.6 Water Systems for Process Use **24**

8.7 Potable water and Service water **24**

8.8 Fire water systems **24**

8.9 The Steam and Condensate System **25**

8.9.1 Steam system 25

8.9.2 Steam Conditions 25

8.9.3 Condensate system 26

8.10 Fuel Gas System (HOLD) **26**

8.11 Syn Gas from Gasifiers (HOLD) **27**

8.12 Fuel Oil System **27**

8.13 Power plant **27**

8.13.1 Emergency power system 27

8.13.2 Uninterrupted power supply (HOLD) 27

8.14 Air System **28**

8.15 Nitrogen System (HOLD) **28**

9 EQUIPMENT DESIGN CONSIDERATIONS 29

9.1 Equipment sparing **29**
9.1.1 ISBL static equipment / packages 29
9.1.2 Continuous rotary equipment 29
9.1.3 Non-critical / non-continuous rotary equipment 29
9.1.4 OSBL ultra critical packages 29

9.2 Equipment overdesign **29**

9.3 Equipment isolation philosophy **30**
9.3.1 Automatic Remote Isolation Valves 31

9.4 Equipment Maintenance Facilities **32**

9.5 Determination of Design Temperature and Pressure **33**
9.5.1 Design Internal Pressure (for pressure vessels) 33
9.5.2 Design Temperature 35
9.5.3 Minimum Design Metal Temperature (MDMT) 35
9.5.4 Vacuum design 36

9.6 Material of Construction related issues **37**
9.6.1 Corrosion allowances 37

9.7 Equipment Design Guidelines **38**
9.7.1 Vessels and Columns 38
9.7.2 Trays and packing 40
9.7.3 Tankage 41
9.7.4 Spheres and Bullets 42
9.7.5 Shell and Tube Heat Exchangers 42
9.7.6 Air Cooled Heat Exchangers' 46
9.7.7 Heaters 47
9.7.8 Rotating Equipment 50

9.8 Instrumentation **54**
9.8.1 General Requirements for instruments on Process P & IDs 54
9.8.2 Standard Utility Line Instrumentation 55

9.9 Piping related guidelines **56**
9.9.1 Engineering Design Basis 56

9.9.2 Hydraulics calculation basis 56

9.9.3 Control Valve manifold 56

9.9.4 Specific technical requirements 57

9.10 Electrical system design related guidelines 58

10 SAFETY, HEALTH AND ENVIRONMENT RELATED REQUIREMENTS 58

10.1 Hazardous properties of Chemicals 58

10.2 Chemical Chemical Interaction Matrix 58

10.3 Chemical Metal Interaction Matrix 58

10.4 Management of highly toxic materials 58

10.5 Inherently safer process design approaches 58

10.6 Hazard identification 59

10.7 HAZOPS 59

10.8 SIL Assessment studies 60

10.9 Risk Analysis 60

10.10 Development of plot plan 60

10.10.1 Baseline data for pollutants and dispersion modeling 60

10.11 Typical safety features 61

10.11.1 For prevention 61

10.11.2 For containment of incident impact 61

10.11.3 For emergency handling 64

10.12 Environmental compliance 64

10.12.1 BAT Analysis 64

10.12.2 Typical provisions for environmental monitoring 65

10.12.3 Noise level limitation 65

11 DOCUMENTATION REQUIREMENTS 65

11.1 Equipment Numbering 65

11.2 Documentation and Document Numbering 65

12 REVIEW AND CLOSURE 66

12.1 Reliance's review requirements 66

12.2 Accountability 66

ATTACHMENT 1 - WIND ROSES AT JAMNAGAR SITE 67

ATTACHMENT 2 - UTILITIES QUALITIES AND TEST METHODS 70

ATTACHMENT 3 - UTILITIES BATTERY LIMIT CONDITIONS 94

1 Purpose

The purpose of this document is to detail out all the basic design information required to form the basis of basic and detailed engineering. This document also references other documents which allow a more detailed insight into the J3 Complex design basis.

2 Scope

This document gives basic design data for the whole of the J3 Complex, (DTA & SEZ), including ISBL, OSBL, Jetty, MTF, Captive Power Plant areas, Sea water RO plants, and is applicable to all the new DTA and SEZ plants.

2.1 Project life

Unless a different figure is specifically mentioned for a particular unit by the licensor for a specific process reason, the design life of the all J3 units is set as 20 years.

3 Definitions

API	American Petroleum Institute
APH	Air Pre-Heater
ASU	Air Separation Unit
ASME	American Society of Mechanical Engineers
ATEX	Atmospheres Explosibles
BEC	Basic Engineering Consultant
BFW	Boiler Feed Water
BMS	Burner Management System
BOD	Biochemical Oxygen Demand
C2 COMPLEX	New petrochemicals complex located east of railway line
CA	Corrosion Allowance
CBD	Closed Blow Down
CCR	Continuous Catalytic Regeneration
CETP	Central Effluent Treatment Plant
CPP	Captive Power Plant
CS	Carbon Steel
DB	Design Basis
DBT	Dry Bulb Temperature
DCS	Distributed Control System
DEC	Detail Engineering Consultant
DMW	Demineralised Water
DSW	Desalinated Water
DTA	Domestic Tariff Area (existing Refinery)

EOT	Electric Overhead Travelling Crane
ESD	Emergency Shut Down
ETP	Effluent Treatment Plant
FCCU	Fluid Catalytic Cracking Unit
FD	Forced Draft
F & G	Fire & Gas
FRP	Fibre Reinforced Plastic
GLC	Ground Level Concentration
HAS	High Alloy Steel
HAZOPS	Hazard and Operability Study
HHP	High High Pressure
HP	High Pressure
HRSG	Heat Recovery Steam Generator
HTDS	High Total Dissolved Solids (water)
IBR	Indian Boiler Regulations
ID	Inside Diameter
IR	Individual Risk
IRI	Industrial Risk Insurers
ISA	International Society of Automation
ISBL	Inside Battery Limits
J3	Jamnagar Phase 3 Projects
JERP	Jamnagar Export Refinery Project
LBEC	Licensor and Basic Engineering Consultant
LDPE	Low Density Polyethylene
LLDPE	Linear Low Density Polyethylene
LP	Low Pressure
LPG	Liquefied Petroleum Gas
LTDS	Low Total Dissolved Solids (water)
MAWP	Maximum Allowable Working Pressure
MCMS	Machine Condition Monitoring System
MCP	Manual Call Point
MED	Multi-Effect Distillation
MOC	Material of Construction
MOEF	Ministry of Environment and Forest
MOF	Material Off-loading Facility
MP	Medium Pressure
MSDS	Material safety Datasheet
MTF	Marine Tank Farm
NB	Nominal Bore
NPSH	Net Positive Suction Head
OD	Outside Diameter

OISD	Oil Industry Safety Directorate
OSBL	Outside Battery Limit
OSHA	Occupational Safety and Health Administration
OWS	Oily Water Sewer
PESO	Petroleum and Explosives Safety Organization
PIB	Plant Instruments Building
PLC	Programmable Logic Controller
PP	Polypropylene
PMT	Program Management Team
PS	Project Specifications
PST	Partial Stroke Testing
PTA	Pure Terephthalic Acid
QRA	Quantitative Risk Assessment
RIL	Reliance Industries Limited
RO	Reverse Osmosis
ROR	Rate of Rise
RPMG	Reliance Project Management Group
SEZ	Special Economic Zone
SIL	Safety Integrity Level
SPM	Single Point Mooring System
SW	Scope of Work
TDS	Total Dissolved Solids
TEMA	Tubular Exchanger Manufacturer Association
TSS	Total Suspended Solids
UPS	Uninterrupted Power Supply
UV	Ultra Violet
VFD	Variable Frequency Drive
VOC	Volatile Organic Compound
WBT	Wet Bulb Temperature

4 Introduction

Reliance Industries Limited operates the world’s largest refinery complex, at Jamnagar, comprising of 2 refineries, DTA + SEZ, with 1350 kbpsd crude throughput, or 1.5% of global refining capacity. The complex produces LPG, Naphtha, Gasoline, Kerosene, Diesel, Sulphur, Coke, Polypropylene, and a number of aromatic products including Paraxylene, Orthoxylene and Benzene.

Reliance Industries Limited, after having successfully commissioned its 2nd mega grass root refining complex under Special Economic Zone (SEZ) in Jamnagar, is considering several value creation projects leveraging the streams of both the refineries.

The J3 will comprise multiple new processing units, located within the Domestic Tariff Area (DTA) and Special Economic Zone (SEZ) with integration / modifications to the existing refineries. The two major projects are the Ethylene and downstream complex (C2 Complex), and the Gasification and associated projects.

Other items in the development include: Offsites, Utilities, CPP, seawater intake, pipelines, tank farm, marine facilities etc.

5 Codes, standards, and software

The data enclosed in this document is applicable to all, - Detailed Engineering Contractors, the Process Licensors and any third party vendors / suppliers.

In case of conflict between this document and other project specific standards / specifications, the matter shall be referred to PMT / OWNER and OWNER's decision shall be final and binding.

The order of precedence of documents to be used on this project is a follows:

- Indian Government Statutory Rules and Regulations
- Requisition Data Sheets
- Requisition and Specifications
- Any mandatory requirements set out by RIL in Project Procedures
- International Codes and Standards

5.1 Specific codes and standards to be used

Refer to individual department Engineering Design Basis Documents for specific Codes and Standards to be adopted for J3 projects. The discipline Design Basis numbers are:

Civil / Structural / Architectural EPCMD-1-ENGG-DBD-CS-001

Seismic analysis	EPCMD-1-ENGG-DBD-CS-002
Piping	EPCMD-1-ENGG-DBD-PP-001
Electrical	EPCMD-1-ENGG-DBD-EL-001
Instruments	EPCMD-1-ENGG-DBD-CI-001

5.2 Software to be used

The Softwares as listed in the table below will be used J3 Projects for major applications.

The consultant / supplier can propose equivalent software's, for these applications for PMT / OWNERS approval. Any additional software required are stated in the respective discipline specifications / design basis documents.

Sr. No.	Engineering activities	Software to be used
1	For hazardous properties of chemicals	CRW
2	Process simulation	Aspen Plus latest version, HYSYS latest version, Pro-II latest version
3	Drafting PFD, Area classification dwg, Electrical equipment layout	AUTOCAD version 2010
4	Drafting of P & IDs	Autocad, Microstation, PDS, PDMS, Smartplant P & IDs
5	Line pressure drop calculations	INPLANT 4.0, PIPENET, KORF, and other validated in-house softwares with DEC
6	Process data sheet	MS Excel 2010, AUTOCAD 2010, PDF
7	Instrument data sheet	SPI 9.2, MS Excel 2010, PDF
8	Line list	MS Excel 2010
9	Pinch Analysis	Aspen Energy Analyzer, KBC Supertarget
10	Thermal Rating	HTRI latest version
11	Fired heaters design	Vendor proprietary software / HTRI module for back-up

Sr. No.	Engineering activities	Software to be used
12	Air coolers	Vendor proprietary software / HTRI module for back-up
13	Flare network	Aspen Flare System Analyzer 7.2
14	Flare noise and radiation	Flaresim 3.0
15	For HAZOPS studies	PHAWORKS or equivalent
16	For SIL studies	EXIDA software or equivalent, Protocols by Reliance for Demand and Consequence assessment
17	Dispersion analysis, Consequence analysis, QRA	PHAST and PHASTRISK
18	Finite element / CFD analysis	Fluent, Gambit and equivalent. ANSYS
19	Pressure Vessel, Heat exchangers Mechanical design	PV Elite, Compress, ANSYS
20	Piping stress analysis	Caesar, NOZZLEPRO, CAEPIPE
21	Structural analysis	Staad, X-Steel
22	PIPE routing / modeling	Microstation, PDS, Smartplant Modules
23	SLD, schematics, datasheets, cable schedule, bulk items management	Smart Plant Electrical
24	Power System Analysis	ETAP, PS Cad
25	Cable routing	Smart Plant 3D
26	Piping network	Pipenet, incompressible / compressible
27	Surge analysis	Flowmaster; Pipenet transient module
28		
29		
30		

6 Units of measurement (UOM)

The following convention shall be used for measurement in the J 3 Complex;

Attribute	UOM	Remarks
Flows of vapours, gas, steam, liquid, catalyst and solids, etc.	tonnes / hour kgs/hr for smaller flows	Density / Mol. wt, temperature and pressure compensation shall be used for critical flows (mass balance, reactor feed, furnace pass, fouling fluids, fuel to furnace, etc.)
System Pressure.	kg/cm^{2}g	
Vacuum	mm Hg abs	
Delta P	mm Hg abs / kg/sqcm	
Attribute	**UOM**	**Remarks**
Temperatures	deg C	
Level	% Vol.	Non-linear level control shall be used wherever applicable.
On line analyzers.	**	** As far as possible the stream specification parameters shall be followed.

The units to be used on this project are tabulated below. Use of units not listed is to be kept to a minimum and must get prior approval from PMT / OWNER.

Quantity	Units for general application
SPACE AND TIME	
Length	m mm
Area	m^2 mm^2
Volume	m^3 l (litre) ml mm^3
Section modulus	mm^3
Second moment of area	mm^4
Time	s h d
Velocity	m/s mm/s

Quantity	Units for general application
Acceleration	m/s^2
Volume Flow	m^3/s l/s ml/s m^3/h
Plane angle	rad degree minute second
Solid angle	Sr
Angular velocity	rad/s
PERIODICITY	
Frequency	MHz kHz Hz
Rotational frequency	rev/s rpm
MECHANICS	
Mass	t (tonne) kg
Mass Flow	t/d t/h kg/h kg/s
Molar Flow	kgmol/h kgmol/s
Volumetric Flow	m^3/h
Normal Volumetric Gas Flow	Nm^3/h (0^oC and 1.033 kg/cm^2a)
Standard Volumetric Liquid Flow	std,m^3/h (15^oC)
Density	kg/m^3
Liquid Absolute Density	kg/m^3 (15^oC)
Momentum	kgm/s
Moment of inertia	kgm^2
Force	N
Moment of force	Nm
Loading (super)	kN/m^2 (structural design)
Loading (linear)	kN/m
Stress	N/m^2
Pressure (Absolute)	kg/cm^2a mmHgA
Pressure (Gauge)	kg/cm^2g
Energy, Work	MJ kJ
Power	MW kW W
Dynamic Viscosity	cP (centipoise) Pa s
Kinematic Viscosity	cSt (centistokes) m^2/s
Surface Tension	mN/m

Quantity	Units for general application			
HEAT				
Absolute temperature	K			
Customary temperature	ºC			
Heat Quantity	Kcal			
Heat flow rate	kcal/hr			
Density of heat flow rate	kcal/m^2hr			
Thermal conductivity	kcal/m^{o}Chr			
Coefficient of heat transfer	kcal/hr m^2 °C			
Specific heat capacity	kcal/kgK			
Specific entropy	kcal/kg			
Calorific value (mass basis)	kcal/kg			
Specific energy, specific enthalpy, specific latent heat	kcal/kg			
Calorific value (volume basis)	kcal/m^3			
ELECTRICITY AND MAGNETISM				
Electric current	kA	A	mA	
Electric charge, quantity of electricity	kC	C	µC	
Electric potential and electromotive force	kV	V	mV	µV
Electric field strength	V/m			
Capacitance	F	µF	pF	
Current density	A/mm^2		A/m^2	
Magnetic field strength	A/m			
Magnetic flux	Wb	mWb		
Magnetic flux density	T			
Self inductance, mutual inductance	H	mH	µH	
Permeability	H/m			
Resistance, impedance, reactance	MΩ	kΩ	Ω	mΩ
Conductance	kS	S	mS	µS
Resistivity	Ωm	µΩm		
Active power	MW	kW	W	
Reactive power	MVAr	kVAr	VAr	
Apparent Power	MVA	kVA	VA	
Electrical energy	MWh	Wh	MJ	kJ
ILLUMINATION				

Quantity	Units for general application
Luminous intensity	Cd
Luminous flux	Lm
Illumination	Lx
Luminance	cd/m^2

Notes:

1. Decibel & pH scales remain unchanged.
2. The inch-pound units shall be used only for all piping system sizing & rating.
3. Standard conditions are 15^{o}C and 1.033 kg/cm^2a.
4. Normal conditions are 0^{o}C and 1.033 kg/cm^2a.
5. Conditions for specific gravity are T^{o}C / 15^{o}C.

7 Site information

7.1 Site data

The site is located at latitude 22^o 22' N, longitude 69^o 51' E adjacent to the town of Jamnagar in Gujarat State alongside the Gulf of Kutch approximately 480 km north of Bombay on India's west coast. The J3 Projects Site is located just to the south of the State Highway No.25 to Jamnagar. The nearest major commercial airport and port is Mumbai, however a dedicated Material Offloading Facility (MOF) was constructed for the original development.

The site is operational. The Marine Terminal / Tank Farm are located on a flat area of coastal scrub land covered with grass and small bushes. The weathered rock is close to the surface approximately 0.5 to 1.5 metres down.

The water table closely follows the surface undulations at approximately 2 metres down, with water wells present on the site. The rubble causeway crosses salt and mud flats until the depth of water and berthing requirements dictates a change to a piled trestle jetty founded on weathered rock. A salt laden coastal atmosphere shall be considered as normal expected environment.

Plant North is true North for the whole project except for the Marine Terminal and Marine Tank Farm which have a plant north that is 16o to the West of true North.

The above data shall be regarded as cursory only and for design, reference shall be made to the Project Soils Report.

7.2 Meteorological Data

The state of Jamnagar experiences a tropical dry climate.

7.2.1 Wind Data

- Onshore Facilities (including J3 projects, J3 Projects Tank Farm and Marine Tank Farm):

  - 50 m/s - 3 second gust wind speed measured at an elevation of 10m above mean sea level. Based on a 50 year return period.

- Offshore Facilities (including the Sea Island, Jetty Approach Trestle and Causeway):

  i) Operational Condition:
  - 15 m/s - mean hourly wind speed measured at an elevation of 10m above mean sea level. Based on a 5 year return period.

  ii) Extreme Survival Condition:
  - 33 m/s - mean hourly wind speed measured at an elevation of 10m above mean sea level. Based on a 500 year return period.

  - 11.5 m/s – wind speed to be used for determining flare heat radiation

Wind directions are as shown on the wind roses in Attachment 1.

7.2.2 Temperatures

Maximum Recorded DBT	48°C
Minimum Recorded DBT	3°C
Maximum Recorded WBT	28°C
Design Temperature (DBT) for Air Coolers	41°C
Electrical Design Temperature	43°C for equipment located outdoors.
Electrical Design Temperature	40°C for equipment located indoors and lighting fittings located outdoors
Design Surface Temperature	65°C *
Winterizing Temperature	10°C †

Low Ambient Design Temperature	7.5°C ‡

* Design temperature for surfaces exposed to solar radiation.

† To be used to determine heat tracing objective temperatures for pour point and freeze protection.

‡ To be used for determining metal temperatures, as required by ASME Pressure Boiler Code, Section VIII Division I.

7.2.3 Rainfall

Maximum rainfall rate	61 mm/h
Maximum rainfall rate (over 24 hr periods)	522 mm / 24hrs

7.2.4 Humidity

Maximum	92.8%
Minimum	27.0%

7.2.5 Atmospheric Pressure:

The site elevation is close to mean sea level; being a coastal location, seasonal variation in ambient conditions is not significant. Exact values for atmospheric pressure shall be advised where required.

Maximum:	1.034 kg/cm^{2}a
Normal/Average:	1.024 kg/cm^{2}a
Minimum:	1.003 kg/cm^{2}a

1.1. Seismic Data

All seismic design shall fully comply with the IS 1893 code and the appropriate spectra for the location. Refer document number EPCMD-1-ENGG-DBD-CS-002.

1.2. Metocean Data

7.2.6 Tide Levels

The following levels are in metres relative to Chart Datum (CD). The terms are used in accordance with the definitions of the Admiralty Tide Tables.

Highest Astronomical Tide	+6.15
Mean High Water Spring	+5.41
Mean High Water Neap	+4.33

Mean Sea Level	+3.10
Mean Low Water Neap	+1.87
Mean Low Water Spring	+0.79
Lowest Astronomical Tide	-0.30
Coastal Flood Line	Same as highest astronomical tide

7.2.7 Surge Levels

Surge levels with extreme tropical storms:

Set-up	0.8m
Set-down	0.3m

7.2.8 Wave Heights

Significant wave heights, wave periods and return periods:

Location	1 : 5 years Operational		1 : 500 years Extreme	
	H_s (m)	T_{m01} (m)	H_s (m)	T_{m01} (m)
Ch 0 – 750	0.9	3.7	0.9	4.1
Ch 750 – 2900	1.1	4.1	1.4	4.5
Ch 2900 – knuckle	1.1	4.1	1.7	5.2
Berth A	1.1	4.1	1.8	5.2
Berth B	1.2	4.2	2.0	5.2
Berth C	1.2	4.2	2.2	5.2
Berth D	1.3	4.4	2.4	5.2

Notes:
1. Wave conditions along the rear of the berthing trestle are 10cm lower.
2. Design wave heights on each side of the causeway are equal.
3. Wave period may deviate by +/- 20%.
4. For operational conditions $T_p = 1.25 \times T_{m01}$
5. For extreme conditions $1.25 \times T_{m01} < T_p < 1.6 \times T_{m01}$
6. Operational waves are monsoon generated.
7. Extreme waves are tropical storm generated.

7.2.9 Current

The following are current velocities, applicable for all berths, for operational and extreme conditions:

Operational 1 : 5 years		Extreme 1 : 500 years	
Flow Direction wrt North [°]	Velocity (m/s)	Flow Direction wrt North [°]	Velocity (m/s)
129.41 +/- 10°	1.60	129.41 +/- 10°	1.85
309.41 +/- 10°	1.20	309.41 +/- 10°	1.35
Other directions	0.25	Other directions	0.70

Actual velocities at the prospective locations of new berth areas shall be verified by float track measurements.

1.3. Noise Level Limits

7.2.10 Overall sound pressure level

The overall sound pressure level dBA value for any equipment shall not exceed 85 dBA at one meter distance from the equipment skid edge

7.2.11 Environmental noise standard

Refer to latest OSHA and MOEF Standards for noise requirements (see section 10.12.3 later).

1.4. Site Access

The overall plot plan for the J3 projects is under evolution. The current plan is to locate the C2 complex and associated units east of existing SEZ complex Avenue M and Railway line to Sikka. The Gasification complex is to south of existing CPP.

Both the sites will be accessed by the following means:

- A single lane metalled road (Highway 25)
- A branch line from the railway which connects Kanalus and Sikka.
- An MOF comprising one or more jetties to enable the import of construction materials and equipment.

- Data relating to the Capacity and size and limitations relating to loads for Rail, Road and Jetty will be established during design evolution of J3 projects.

8 Utility Information

8.1 General

J3 projects Utilities generation systems shall be evolved as more information is available from Process Licensors' as to utilities requirements for process plants. Design principles are outlined on similar lines with existing installations at DTA and SEZ refineries.

J3 projects will generate all secondary utilities from sea water and coke and imported natural gas.

Utilities systems will be integrated with corresponding DTA refinery or SEZ refinery utilities systems.

Layout shall have provision for future modular units, from which appropriate tie-ins for future equipment may be made.

8.2 Utilities distribution

All ISBL utility distribution systems are to be sized for 10% greater capacity than the estimated design requirement except in case of cooling water networks that should be designed for 20% greater capacity than the estimated design requirement. OSBL utility distribution headers are to be sized for the greater of

a) 120% of Design Flow – which is the sum of the process unit design flows (maximum operating load) on the header or

b) 110% of Maximum Flow – which is the sum of process unit design flows on the header plus the largest difference between a process unit design and its maximum flow.

8.3 Sea Water System

Sea water will be pumped from an intake system to an RO unit located on the coast near the Marine Terminal. Sea water will be filtered to remove turbidity to meet the requirements of desalination unit. Sludge from the sea water filtration unit will be disposed of in a manner consistent with environmental norms and considering current practices.The sea water will be chlorinated to control biological fouling.

The sea water supply lines are to be sized to cater for the maximum flow rate of the sea water intake basin.

In J3 projects, sea water will be used for the following purposes:

- As a feed for the Sea Water RO Desalination Units
- As make-up water for the Sea water cooling towers

Specification for seawater is included in the table in Attachment 2.

Typical battery limit pressures and temperatures are indicated in Attachment 3. These numbers will be firmed up as system design progresses. Return sea water from the desalination units and the sea water cooling towers will be returned to the sea at appropriate distance and depth into the sea, through suitably designed outfall system. The system will ensure diffusion as per practices earlier adopted for DTA and SEZ refineries.

8.4 Desalinated Water System

The J3 projects will have an RO unit for sea water desalination. This will be located in MTF within DTA refinery.

Desalinated water will be used as:

- Supplementary make-up water in the process cooling towers
- Feed for the DMW system
- Supplementary feed for the potable / utility water system
- One of the feeds for the fire water system

DTA refinery and SEZ refinery currently use the multi-effect distillation (MED) process with filtered sea water from MTF as feed. The cooling water for the Desalination Unit is from the sea water.

Specifications for desalinated water streams are included in the table in Attachment 2.

Typical battery limit pressures and temperatures are indicated in Attachment 3. These numbers will be firmed up as system design progresses.

8.5 Cooling water systems

The J3 projects will use open recirculating type cooling towers as in DTA and SEZ refineries. Number of cooling towers will be installed in the overall plot space each serving a group of process units.

As in DTA and the SEZ refineries, there may be principally two types of cooling water systems:

- The fresh water cooling system (normally DSW / LTDS, but some individual towers may be supplied by LTDS only)
- The sea water cooling system

Specification for make-up water is included in the table in Attachment 2.

Typical battery limit pressures and temperatures are indicated in Attachment 3. These numbers will be firmed up as system design progresses.

8.6 Water Systems for Process Use

The J3 will have its own separate water systems for process use. DM water can be used directly in Process plants or as make-up to Boiler feed water.

J3 will have three BFW systems supplying to process units with HP, MP and LP BFW.

The process BFW systems can preferentially use recovered process condensate as make-up water to the Process Deaerators with DMW used to make up any shortfall.

Specification for BFW is included in the table in Attachment 2.

Typical battery limit pressures and temperatures are indicated in Attachment 3. These numbers will be firmed up as system design progresses.

8.7 Potable water and Service water

DSW from RO unit will preferentially be used as potable water once it has been treated in the Passivation and Chlorination Units.

The plant's service water system is fed with raw water with supplementary make-up from potable water. The safety showers and eye-wash stations shall be supplied with potable water and the exposed metal lines shall be insulated to avoid heating of stagnant water by solar radiation.

Specification for potable water and service water are included in the table in Attachment 2.

Typical battery limit pressures and temperatures are indicated in Attachment 3. These numbers will be firmed up as system design progresses.

8.8 Fire water systems

Existing fire water systems shall be extended for J3 Process units, the tank farm, the marine tank farm and the jetty except in the case of plants located east of railway line. The fire water systems will use raw water / desalinated water as both initial fill and make-up water during fire-fighting except in the case of marine tank-farm area where initial fill will be with desalinated water and sea water will be used during fire-fighting.

Specification for Fire water is included in the table in Attachment 2.

Typical battery limit pressures and temperatures are indicated in Attachment 3. These numbers will be firmed up as system design progresses.

The fire water network should be designed based on the tallest tower in the complex or additional booster pumps are to be provided for ISBL sections having tall towers.

The fire water lines should be preferably laid underground. In case fire water lines are laid aboveground, these shall be laid out in a manner so as not to be exposed to any blast intensity beyond 0.35 psi.

8.9 The Steam and Condensate System

8.9.1 Steam system

The J3 projects will have their own separate steam and condensate systems. These systems will be integrated with DTA and SEZ refinery systems.

In J3, steam will be available on-site at HHP, HP, MP and LP steam conditions. HHP steam and HP steam will be used to drive turbines, in the process reducing the HHP steam to HP, MP and LP steam, which will then be distributed to the rest of the J3 complex. HP steam can also be used to drive smaller turbines.

The temperatures and pressures of each level shown in Attachment 3 reflect the conditions at the battery limit of consumer plants. The OSBL designer shall ensure that these parameters are satisfied.

8.9.2 Steam Conditions

Systems are identified in general terms such as High High Pressure (HHP), High Pressure (HP), Medium Pressure (MP), Low Pressure (LP), etc., or as nominal pressure levels, or in any other suitable terms.

<u>Definitions:</u>

- MINIMUM describes the lowest steam pressure and temperature expected inside the process battery limits during normal operation.

- NORMAL describes the average or typical steam pressure and temperature expected at the process battery limit during normal operation.

- MAXIMUM describes the highest steam pressure and temperature expected inside the process battery limits during normal (non-relieving) operation.

- DESIGN describes pressures and temperatures used for the mechanical design of piping and equipment - excluding steam generation equipment designed under the provisions of the ASME Boiler and Pressure Vessel Code, Section I. These conditions are particularly important if matching existing equipment or design is done by others.

<u>Methodology of how this information is to be used:</u>

- Steam consuming equipment connected to a steam header will in general be specified based upon the minimum steam conditions and reviewed for satisfactory operation anywhere between the maximum and minimum steam header conditions.

- Normal steam conditions will be used for utility estimates, heat and mass balances, etc.
- Steam generating equipment connected to a steam header will in general be specified based upon the maximum steam conditions and reviewed for satisfactory operation anywhere between the maximum and minimum steam header conditions.
- Design conditions will be considered to establish relief valve set pressures and mechanical design.

Steamout Conditions

- Hydrocarbon lines and vessels in the process area should be checked for steam-out conditions of 0.5 kg/ cm^2a at 150°C, when specified for steam-out conditions in the vessel data sheet or line sheet.

8.9.3 Condensate system

In J3 complex, when used as a heating medium HP steam will be condensed and then flashed to MP conditions. Also, the steam traps on the HP network discharge to the MP network. This process is repeated for MP and LP steam until LP condensate is produced (at atmospheric conditions).

In the J3 complex, recovered polished condensate will be used as feed water for the Process BFW system which is used in the process steam generators. In J3 complex, demineralised water shall be used to make up any deficiency of process condensate for both the Process and CPP BFW systems. Contaminated condensate will be diverted to the low TDS effluent system.

Specification for steam and condensate are included in the table in Attachment 2.

Typical battery limit pressures and temperatures are indicated in Attachment 3.

8.10 Fuel Gas System (HOLD)

Off-gases from DTA and SEZ refineries will be collected and routed to the C2 complex. At C2 complex, available ethylene will be recovered and rest of the gas stream will be passed through cracking furnaces for production of additional quantity of ethylene.

Part of the fuel gas will be utilized for the C2 complex and a return fuel gas stream, rich in nitrogen, shall return to DTA refinery.

The J3 complex will be supplied with Natural Gas via a pipeline.

A central fuel gas collection drum will act as a mixing vessel and a knock-out pot to remove any entrained or condensed liquid in the fuel gas. Any excess liquid in this drum will be drained to the low pressure flare.

In the event of low pressure in the fuel gas network, a steam heated vaporiser will evaporate LPG into the system. Dual fired burners are to burn as much fuel oil (in preference to fuel gas) as is practicable whenever a low pressure situation develops in the fuel gas system. Normal firing for these heaters is fuel gas.

The quality of the fuel gas will be variable depending on the operating capacity and number of other parameters in the J3 complex. Indicative specification for fuel gas and syn gas and natural gas are included in the table in Attachment 2.

Typical battery limit pressures and temperatures are indicated in Attachment 3. These numbers will be firmed up as system design progresses.

8.11 Syn Gas from Gasifiers (HOLD)

Syn Gas from gasifiers will be scrubbed, purified and sent to OSBL. From OSBL, the gas will be routed to GTs (new and existing) and also linked to lower pressure Fuel gas system. In future, the Syngas system will have other linkages for process uses.

8.12 Fuel Oil System

Use of Fuel oil is not envisaged in the J3 complex.

8.13 Power plant

Equipment for power generation, are proposed to be arranged in C2 complex and Gasification complex along with HRSGs and Auxiliary boilers. These machines will generate power at 14.5 KV and 11 kv levels and be integrated with existing generators at 220 kv level.

Brief specifications of power are furnished in Attachment 2. Attachment 3 indicates typical voltage levels.

8.13.1 Emergency power system

Emergency power requirements of the individual process unit, in case of power failure in the respective units, or total blackout will be catered from Distributed generation of Emergency power through Diesel Generator sets which will be provided at strategic locations to cover one or more of the process units.

Emergency power will be distributed to a group of plant from DG sets at 415 Volts (3phase+N) or 6600 Volts 3 Phase depending on the quantum of emergency power requirements.

8.13.2 Uninterrupted power supply (HOLD)

Singe phase uninterrupted power will be supplied to critical instrumentation and control systems by 110 V AC Invertors with battery backup of 30 minutes. It is envisaged that emergency DG sets will be available within 30 minutes and supply power to UPS system. UPS system will have No break static transfer switches to ensure uninterrupted power to critical instrumentation and control system.

8.14 Air System

The J3 projects will have their own separate air systems. The instrument and plant air are likely to be generated at three locations, a) Gasification DTA b) Gasification SEZ and c) C2 complex.

All plants provide oil free, water saturated plant air and oil free instrument air with a water dew point of -40°C at normal supply pressure.

Volumetric capacity equal to 20 minutes normal consumption of instrument air will be incorporated into the system to provide safe shutdown on loss of instrument air from source. This will be achieved using a high pressure dry air storage vessel with 'hold-up' volume of 20 minutes normal consumption between 40 kg/cm^2g and 6 kg/cm^2g.

Specification for plant and instrument air and breathing air are included in the table in Attachment 2.

Typical battery limit pressures and temperatures are indicated in Attachment 3.

8.15 Nitrogen System (HOLD)

Major nitrogen generators in the J3 complex will be ASUs associated with EO/EG unit in C2 complex and ASUs associated with Gasification units in DTA and SEZ Gasification areas. Definition of these facilities is in progress.

In the ASUs associated with Gasification units, Nitrogen will be produced by a cryogenic air separation process in both gaseous and liquid forms. Some liquid nitrogen will be stored local to the cryogenic plant for use as nitrogen back-up in times of excessive demand e.g. start up and tank inbreathing in the tank farms.

The high purity nitrogen will be dry, oil free and 99.998 vol% pure. Oxygen contamination is to be kept below 10 ppm v/v.

Lower purity gaseous nitrogen from these units will be compressed and routed to GTs as diluents for NOx reduction.

Units that require higher purity nitrogen, for example LDPE and LLDPE in the C2 complex, will be supplied Gaseous Nitrogen (GAN) from ASU to be located in EO/EG plant. ASU at EO EG Plant will supply high purity Nitrogen with O_2 content of less than 5 ppm at 7.7 Barg.

Specifications for nitrogen are included in the table in Attachment 2.

Typical battery limit pressures and temperatures are indicated in Attachment 3.

These numbers will be firmed up as system design progresses.

9 Equipment design considerations

9.1 Equipment sparing

9.1.1 ISBL static equipment / packages

Typically, items of static equipment in individual units are not spared. One exception would be adsorption units and similar installations that may require periodic regeneration and the operating bed has a spare that is regenerated and kept ready to maintain continuity of operation.

9.1.2 Continuous rotary equipment

All continuous running pumps and reciprocating compressors shall have installed spare. In critical compression applications, the complete package inclusive of compressor, turbine, expander, motor, gearbox and auxiliary system shall be in compliance to relevant project specification (referenced to relevant API standards). In certain packages, vendor standard equipment may be accepted on case to case basis.

In certain critical compression applications, machines with split capacity can be explored. For critical agitators, warehouse spare rotor should be considered.

9.1.3 Non-critical / non-continuous rotary equipment

For intermittent services, sparing philosophy shall be decided from case to case basis.

9.1.4 OSBL ultra critical packages

The common facilities, OSBL of all process units house installations that serve many units and discontinuation / disruption can have economic repercussions and may also create safety issues at other parts of the complex.

These packages, for example Power and steam generation systems, Air compression system, Nitrogen generation system and similar installations are typically planned with one spare module so as to ensure continuity of supply in spite of outage or maintenance.

In certain packages, for example ETP, sparing is at sub-assembly level rather than the entire unit.

Provision of spare knock out drum and flare stack can be considered where the complex never completely shuts down. This is expected to be the case for J3 Complex.

9.2 Equipment overdesign

Equipment sizing shall be carried out at the larger flowrate from the following alternates:

1. Percentage higher flow recommended by Licensor for equipment sizing, over the controlling case steady state flow rate on PFD / Heat and Material Balance

2. Ten percent higher flow over the controlling case steady state flow rate on PFD / Heat and Material Balance.
   a. However, if controlling case is not for current operation, but is for future proofing purpose, such margin need not exceed 5%.
3. The percentage higher flow rate recommended by empowered representatives of RIL over the controlling case steady state flow on PFD / Heat and Material Balance.
   a. In case, this percentage is higher than alternates 1 and 2, the justification shall be documented.

9.3 Equipment isolation philosophy

Sr. No.	Equipment
1	Spectacle blinds shall be provided for all lines connected to process vessels, tanks for line size 8" and above for 150# rating; and for line sizes 6" and above for 300# and higher ratings. Spectacle blinds are not required for instrument connections. In case, different requirements are indicated for a Piping specification, the Piping specification will prevail.
2	For line size above 12" (300 NB) spade and spacer should be used for positive isolation. In case, different requirements are indicated for a Piping specification, the Piping specification will prevail.
3	For 900# rating and above piping and other services, where specified, double block valves shall be considered for isolation.
4	Isolation valves shall be provided on inlet and outlet lines where maintenance can be performed on the exchanger, with unit operating. Provide spectacle blinds at inlet and outlets where maintenance valves have been provided in process and steam services and the line sizes are 8" and above for 150# rating, and 6" and above for 300# and higher rating. In case, different requirements are indicated for a Piping specification, the Piping specification will prevail.
5	Control valves isolation and bypass valves shall be as per ISA standard Control valve bypass valves above 8" shall be gate valve (except in critical services where, for all sizes, the bypass valve will be tagged on P & IDs, be of same construction and CV as the control valve and operated through HICs. Such valves shall be in the scope of Instruments engineering to procure and not Piping engineering group.

Sr. No.	Equipment
6	Spectacle blinds may be provided for pump isolation in applications where such isolations are considered essential.
7	Spectacle blinds should typically be provided at battery limit isolation valves.

For battery limit isolations at the unit sub-headers for flare network, special high integrity butter fly valves may be used unless specifically required to use variation of gate valve by Licensor / BEC.

All critical / fouling Heat exchangers/ Reboilers shall have isolation and bypass facility with in-situ cleaning arrangements appropriate for the service. If it is possible to operate the plant with any exchanger by-pass, shell and tube side block and by-pass valves shall be provided.

Isolation Valves shall be provided on supply and return cooling water lines of heat exchanger. Gate / butterfly valve shall be provided on supply line and return line as per piping specifications.

Flow control of cooling water to an exchanger is not desired. However, if it becomes a must, the velocity through the tubes must not be less than 1 m/sec even under bypass conditions; control valve, if any, shall be on bypass line only.

9.3.1 Automatic Remote Isolation Valves

1. Automatic remote isolation valves shall be considered between process vessels and pumps with mechanical seals, in the following applications. The closure of these valves shall result in the automatic shutdown of the corresponding pumps.

    - Upstream vessel / tank inventory is 7.5m^3 or more of n-butane or lighter hydrocarbons
    - Upstream vessel / tank inventory is 50m^3 or more of C5 or heavier hydrocarbons in order to isolate large inventories where pump seal failure could result in large uncontrollable releases.
    - Where the vessel contents are at temperatures higher than the auto-ignition temperature or at temperatures above 250 degree C (600 degree F as per API 553.

2. In non-pumped systems, remote isolation valves are to be provisioned for similar applications as in case of pumped systems (point 1 above).

3. At major lines entering or leaving a system of vessels, containing more than 4.5 tons of flammable chemicals, which operate together to perform a unit operation such as distillation, refrigeration or reaction. For example in an ethylene plant, an automatic remote isolation valve is often installed in the feed line to a distillation unit and another automatic remote isolation valve is installed in the outlet line from the unit to the next process unit

Remotely operated Automatic shutdown valves should also be considered on applications as identified below and decided on a case to case basis.

4. Where the equipment contain highly toxic material
5. At the battery limits for pipelines containing highly toxic materials
6. To reduce the consequences of a fire in compressor area, remote activated isolation valves may be installed in the suction and discharge of any compressor with a power higher than or equal 150 kw and handling flammable or toxic gases, to be decided on a case to case basis.
7. At the inlet and outlet of highly exothermic reactors;
8. Where risk of line failure is considered to be higher than normal (judgment based on experience)

9.4 Equipment Maintenance Facilities

Permanent facilities for maintenance of equipment, such as compressors, pumps, blowers, exchangers etc. shall be provided as detailed below:

Item	EOT	Davit	Lifting beam	Lifting hook	Others
Turbine / Compressors	√		√		
Pumps and drives (small)				√	
Vertical Pumps			√	√	
Pumps and drives (large) & sump Pump			√	√	
Vessel man holes		√	√		
Agitator (large)		√	√	√	
Ejector				√	
Safety valve (large)		√			

Item	EOT	Davit	Lifting beam	Lifting hook	Others
Exchanger on ground			For small		Mobile Crane
Exchanger on structure			For small		
Catalyst loading			√		
Filters		For small	For large	For large	

EOT sizing shall be based on maximum maintenance weight (not the maximum installation weight).

9.5 Determination of Design Temperature and Pressure

The design internal pressure is set such that relief devices will activate only in emergency conditions and such that the relief devices will have adequate blow down margin. The design external pressure is set such that vacuum breaking devices are not required or such that vacuum relief devices will have adequate pressure drop to provide protection.

9.5.1 Design Internal Pressure (for pressure vessels)

The design internal pressure is determined : a) for equipment (and piping) at discharge of pumps and compressors as explained below b) and c) for low pressure equipment where provisioning separate PSV is not economical as explained below d) from the maximum operating pressure, applying margins as in the following table.

a) In case the design pressure for pump / compressor discharge side is computed by adding maximum pump / compressor discharge head to the maximum suction pressure, additional margin is not required.

When using the approach of adding maximum of either, normal suction / maximum differential or maximum suction / normal differential, the margin from the table below should be applied. Computation of maximum differential head should account for frequency variation as appropriate.

b) Maximum pressure resulting from (potential) flow from a higher pressure system to a lower pressure system plus margin from table below (unless the lower pressure system is protected by a PSV).

c) Maximum cold liquid vapour pressure at ambient temperature plus margin from table below (unless economics dictates protecting the equipment with a relief valve set at lower pressure).

d) Table for margin to be added to internal pressure

Range of Maximum Operating Pressure	Design Pressure
Vacuum to 1.8 kg/cm^{2}g (25 psig)	Typically 3.5 kg/cm^{2}g (50 psig)
1.8 kg/cm^{2}g (25 psig) to 17.6 kg/cm^{2}g (250 psig)	Max. Operating Pressure + 1.8 kg/cm^{2}g (25 psig)
17.6 kg/cm^{2}g (250 psig) to 35.2 kg/cm^{2}g (500 psig)	Max. Operating Pressure x 1.1
35.2 kg/cm^{2}g (500 psig) to 70.3 kg/cm^{2}g (1000 psig)	Max. Operating Pressure + 3.5 kg/cm^{2}g (50 psig)
Over 70.3 kg/cm^{2}g (1000 psig)	Max. Operating Pressure x 1.05

Note 1

Maximum static head condition can be additive to margin from table above for items in Section (a) through Section (d) above.

For example the design pressure of reflux drums should be set sufficient high to ensure that when the column relief valves (that are protecting the system) are operating at full accumulation the static head of the flooded condenser (from the condenser relief valve to the reflux drum relief valve) should not lift the reflux drum fire relief valves.

Note 2

These margins are based upon “typical” relief valve blowdowns / simmer.

The design intent is to ensure that the reseating pressure and simmer pressure of the relief valve is higher than the vessel maximum pressure in its normal operation mode. Some relief valves, for instance those in vapour and liquid service, may have higher blowdowns and require additional margin. On the other hand, pilot relief valves have a small Blowdown and require a significantly smaller margin.

There may also be a reason to design with extra margin between operating and design pressure to minimize the likelihood of a relief valve opening, particularly if the fluid handled is toxic or produces a disposal problem when relieved.

Increasing the equipment design pressure (for example to 5.3 kg/cm^2 g for low pressure equipment), may involve very small cost escalation for many equipment, (controlling case may be wind load / earthquake), but it can reduce the size of the corresponding PSV and associated relief system. Judgment will be exercised in these cases.

9.5.2 Design Temperature

This section of the guideline shall be used for OSBL; for ISBL, licensors guideline shall be followed. Where not specified elsewhere in this document, the Design Temperature shall be 28 ^{0}C (50 ^{0}F) plus the coincidental temperature at the Design Pressure. The maximum design temperature determines the maximum allowable stress to be used for mechanical design of equipment. For temperatures beyond 343^{0}C (650^{0}F), the Design Temperature shall be 14 ^{0}C (25 ^{0}F) plus the coincidental temperature at the Design Pressure.

In cases where a temperature for a process upset scenario exceeds the maximum operating temperature plus 28^{0}C (50^{0}F) guideline, additional margin on the upset temperature is not required to set design temperature.

For equipment that may be under the purview of PESO, the minimum design temperature on the positive side shall not be less than 65^{0}C.

9.5.3 Minimum Design Metal Temperature (MDMT)

This section of the guideline shall be used for OSBL; for ISBL licensors guideline shall be followed).

The minimum design metal temperature for new design units is the most stringent of the following:

- The minimum ambient temperature less 5.6 ^{o}C (10^{o}F).
- The minimum operating temperature less 5.6 ^{o}C (10^{o}F).

- The minimum equipment temperature caused by depressuring down to the constant superimposed back pressure of the flare header.

Note that in many cases (e.g. systems containing light hydrocarbons) the MDMT will likely be controlled by the depressuring criteria.

Note that the 5.6°C (10°F) margin is not applied to the minimum design metal temperature for depressuring.

It must also be noted that under conditions of depressuring, the equipment integrity needs to be ensured only for the maximum superimposed back pressure under conditions of depressuring without any reference to normal operating pressure inside the item of equipment (reference API RP 579 – Fitness for service).

9.5.4 Vacuum design

Vacuum design condition is indicated for all equipment that normally operates under vacuum conditions, or is subjected to evacuation during startup, shutdown and regeneration.

Vacuum design is also specified for vessels which normally operate liquid full and that can be blocked in and cooled down, and for fractionators and associated equipment that can undergo a vacuum condition through the loss of heat input.

Steam condensers, steam reboilers or heaters, condensate pots, direct steam injection equipment to be designed for full vacuum.

Columns and vessels subjected to steam out to be designed for at least half vacuum (0.5 kg/cm^2a).

Equipment is not designed for full vacuum conditions due to blocking in after steam-out or any other operator mal-operation.

Where it is impractical to design low pressure equipment to accommodate vacuum conditions, (for example atmospheric tanks), the items of equipment are protected by drawing in air or nitrogen.

9.6 Material of Construction related issues

Primary metallurgy for items of hardware exposed to process fluids shall be advised by the Licensor / BEC through Material Selection Diagram (MSD) and individual data sheets and P & IDs. These will be further elaborated and specified in detail with exact material grades by the DEC.

Metallurgy and corrosion allowance needs to be specified considering a 20-year life minimum.

9.6.1 Corrosion allowances

Licensor recommendations will be the starting point for fixing corrosion allowances.

For static equipment

Material	**Minimum Corr. allowance(CA)**
Carbon Steel / Low Alloy Steel (up to 2 ¼ % Cr)	3 mm
Low Alloy Steel (above 2 ¼ % Cr and up to 9% Cr)	1.5 mm

Cladded equipment

Minimum thickness for cladding is 2 mm.

If equipment is cladded, thickness of cladding is considered as CA with minimum of 3 mm.

If equipment is overlaid, undiluted thickness of weld overlay is considered as CA with a minimum of 3 mm.

Storage Tanks

For storage tanks corrosion allowance shall be considered as 1.5 mm for shell and bottom. For roof, corrosion allowance shall be considered as 1 mm.

Process Piping

Material	Environment	Minimum Corrosion Allowance (CA)
Carbon Steel	Non-corrosive	1.5 mm
	Mildly-corrosive (Hydrocarbons, Steam, etc.)	1.5 mm
	Moderately-corrosive (Amines, Caustic, Wet sour gas, Sour water, etc.)	3 mm
Low Alloy Steel (up to 9% Cr)		1.5 mm
Stainless Steel (11 % Cr and above)	Non-corrosive	0 mm
	Corrosive	1.5 mm

9.7 Equipment Design Guidelines

9.7.1 Vessels and Columns

Process issues

Equipment design shall be based on final material balances with agreed overdesign margins. Physical properties used must have been validated.

For separators, review shall be done on a case by case basis for acceptable liquid holdup and vapour / liquid disengagement space.

Sizing / rating issues / MOC

Proven rating calculations shall be used, documented and checked and verified.

Vessel diameter shall be specified on ID basis.

When required, liquid drop legs (draw-off boots) shall be provided on horizontal vessels as follows:

- If the vessel is lined and the drop leg diameter is less than 30”, the drop leg will be of lining material and flanged to the vessel.

- If the vessel is lined and the drop leg diameter is 30” or greater, the drop leg will be internally lined and welded to the vessel.
- If the vessel is un-lined, the drop leg will be un-lined and welded to the vessel regardless of the drop leg diameter.

Mechanical design

The Design and Construction pressure vessels, columns, reactor will follow ASME Section VIII Div I or Div 2.

Boilers and other steam equipment shall be designed as per IBR.

Equipment foundations shall be typically designed for water filled condition, except where not required as per Civil / Structural design basis / guideline.

Manways

On unlined horizontal vessels, a manway will be provided on the side of the vessel at or below the horizontal centerline. If bottom half of the vessel is lined, the manway shall be located on the upper side or top of the vessel unless specifically required. On horizontal vessels over 3m in tangential length, a blanked off ventilation nozzle shall be provided on top of the vessel. near the end opposite the manway.

Manhole sizes shall be as follows:

Vessel dia 900 mm to 1500 mm 20” NB

Vessel dia above 1500 mm 24” NB

Minimum ID of manhole shall be 20”.

Larger manhole sizes shall be specified when required to accommodate internals.

For vessels below 900 mm diameter if access to inside of the vessel is not required, hand hole may be provided instead of body flange. For column less than 900mm diameter, intermediate body flange shall be provided.

Nozzles

Connections on pressure vessels shall be flanged, unless welded construction is preferred for reasons of safety.

Separate 2” nozzle shall be provided as steam-out or utility connections.

Vessels will be provided with vent and drain nozzles as following:

		Volume		Nozzle size (NB)
Vent		up to 6 m^3		1 ½”
		above 6 m^3		2”
Drain		up to 6 m3		1 ½”
		6.1 to 15 m^3		2”
		above 15 m^3		3”

9.7.2 Trays and packing

Process issues

Equipment design shall be based on final material balances with agreed overdesign margins. Physical properties used must have been validated.

Fractionation specification will be agreed in design basis kick off meetings

Maximum jet flooding of 80 % of flood shall not be exceeded. Downcomer clear liquid backup should be 45% maxm and choke flood should be 75% maxm. These shall be reviewed on a case by case depending on the type of trays / packings involved.

Type of trays specified for fractionation service: sieve trays, valve trays or packing will be based on process considerations.

Where recommended by Licensor, economics of installing MD (multi-downcomer trays) or other high capacity trays may be studied for an application; but these are typically used for revamp projects only.

Packed column shall have differential pressure indicator across each bed of packing, feed and reflux lines to packed columns shall be provided with duplex strainers.

All distillation columns shall have PDT indication either through separate standard and properly calibrated PT at top and bottom of the column for practical reasons or a DPT across the trayed sections / packing sections.

Sizing and rating issues

Proven rating calculations shall be used, documented and checked and verified.

Fractionator trays are generally designed for the same turndown as indicated for the process units. However, in some services, the reflux rates and reboiler duties may not be turned down in proportion to the unit turndown when higher tray loadings are required to maintain desired efficiency.

Trays are numbered from top to bottom.

Three pass and four pass trays are specified where deemed appropriate.

Mechanical design

Trays of diameter less than 900 mm shall be of cartridge design.

Removable trays, deck plates, removable pans thickness should be minimum 2 mm thickness (SS) and 3 mm for CS; without corrosion allowance for all removable column internals. Trays should be designed for minimum uplift force of 150 kg/m^2.

All the fasteners should be of SS or better metallurgy.

Manways

In trayed columns manhole, will be provided above top tray, below bottom tray, at feed tray, at any other tray at which any removable feed distributor etc. are located which need periodic inspection/ maintenance. Size of part of the internal should not exceed the size of manhole

The maximum spacing of column manhole shall not to exceed 10 meters (or does not exceed 15 numbers of trays). One manway 400 X 450 mm size per pass shall be provided. When manway is not feasible split-tray shall be considered. Five trays above and below two-phase feed shall be provided with locknuts and shall be capable of withstanding a net pressure of min 450 kg/m^2.

9.7.3 Tankage

Process issues

The tanks shall be designed considering a specific gravity of fluid stored as 0.9 minimum if the specific gravity is of lesser magnitude and test fluid specific gravity as 1.0 to allow for water fill test.

Nitrogen / Fuel Gas blanketing is provided when storage temperature is more than the flash point of the liquid stored to prevent air ingress in vapor space and formation of flammable atmosphere.

Mechanical design

The design and construction of storage tank will follow API 650 for atmospheric storage tanks and API 620 for low pressure storage tanks. Modification of tank shall follow API 653.

9.7.4 Spheres and Bullets

Mechanical design

- Design Code – ASME Sec-VIII Div 2.
- OISD guidelines to be used.
- MOC shall be SA 516 Gr 60 only
- On pressure vessels, minimum nozzle size shall be 1 ½".

9.7.5 Shell and Tube Heat Exchangers

Process Issues

Equipment design shall be based on final material balances with agreed overdesign margins. Physical properties used must have been validated.

Licensor process datasheet is to be followed for type of Heat exchanger wherever specified, following guidelines to be used in absence of datasheet from licensor. Preferred exchanger type will be horizontal, single pass shell, floating head tube bundle arranged with two or more tube passes per shell.

Tube pitch will be square or rotated square for fouling service on the shell side. Tube pitch can be triangular if shell side fluid is non-fouling.

Double pipe or multitube type exchangers can be used in services where the surface area is less than 10 m^2 and shall be of non removable type. Hairpin (multitube type) may be used up to 50 m^2.

No limit on new exchangers / coolers subject to availability of plot space. High LMTD is to be avoided to minimize leak / bowing. Exact magnitude can be a function of exchanger type / mechanical design.

Vertical thermosiphon, horizontal thermosiphon, or kettle type reboilers are used where appropriate. Vertical thermosiphon reboilers may be used where there is a process advantage and there is suitable access. For vertical thermosiphon Reboilers, the top tube sheet elevation should not be higher than the Low low level in the column, to ensure that the tubes are always filled in liquid phase. In case of circulating thermosiphon reboiler every effort shall be made to maintain the vapor fraction mentioned in the process data sheet. However if it is not feasible to maintain the % vapor fraction it is acceptable to have up to 5% variation in vapor fraction against what has been specified on the licensor data sheet.

Sizing / Rating issues

Proven rating calculations shall be used, documented and checked and verified. General guideline for fouling factors is to be as the table below. All values are in $hr.m^2.°C/kcal$

Fluid	**Recommended fouling factor**
Fresh CW	0.0003
Sea Water	0.0006
Steam	0.0001
Condensate	0.0002
HC	Typically not less than 0.0003 (actual would depend on nature of HC and as per licensor’s specifications)

Recommended type of heat exchangers based on fouling factors is shown in the table below. This approach to selecting the type of exchanger is indicative and shall be reviewed on a case to case basis.

Shell side fouling h m^2 ^0C/kcal	Tube side fouling h m^2 ^0C/kcal	Type of exchanger
> 0.0002	> 0.0002	Floating head
< 0.0002	> 0.0002	Fixed tube sheet. if fluid is not hazardous.
> 0.0002	< 0.0002	U tube bundle
< 0.0002	< 0.0002	Fixed tube sheet / U-tube

Velocity in exchanger tubes shall be as per following criteria:

Fluid	**Minm.**	**Maxm.**
Cooling Water	1.3 m/s at normal flow	Based on MOC
Residues, Heavy Oil	1 m/s turndown	
Slurry oil	1.5 m/s @turndown	2.3 m/s @ turn up

Choice of tube OD based on fouling factor can be as per table below:

Tube side Fouling resistance	Minm. Tube OD, mm
>0.0004 hrm^2 ^0C /kcal	25
<0.0004 hrm^2 ^0C /kcal	20, 25

Preferred tube length for fixed tube sheet, 'U' tube or floating head type exchanger is 6.0 m. If economically justified, following alternate tube lengths may be used 15m, 12m, 9 m, 4.5 m, 3 m. 'U' tube exchanger may not follow standard tube length.

Avoid higher LMTD across exchangers/ water coolers to eliminate tube leak / bowing.

Mechanical design

The design and construction of heat exchangers will follow TEMA, ASME Section VIII Div.1 and API 660. (latest section) & IBR.

For U-tube construction, stationary head shall be TEMA type B or C except when Tube side medium is water. When 'B' head is used, the tube-sheet shall be full Diameter type, with threaded holes that permits testing of shell side after removing the stationary head.

Selected heat exchangers will use lower tube thicknesses as appropriate to meet normal Licensor or vendor standards, specifically for stainless steel and titanium; confirmation for the compliance with IBR is required.

Low pressure side of Shell and tube heat exchanger (including upstream and downstream systems) shall be designed for at least 10/13 times of the design pressure of high pressure side. This is to eliminate requirement of pressure relief for tube rupture.

Tube Specifications shall be as following

Material	Tube OD	Thickness (minimum)	IBR
Carbon Steel / Low Alloy Steel	20	2 mm	2.3
	25	2.1 mm	2.3
Stainless Steel	20	1.6 mm	2.1
	25	2 mm	2.1
Titanium	20	1.245	1.245 mm

Corrosion allowance should be 3 mm minimum for carbon steel / low alloy steel (except for tubes). Tube to tube-sheet joint should generally follow TEMA stipulations.

For critical applications, the tube to tube-sheet joint shall be expanded into 2 grooves and seal welded type.

<u>Nozzles</u>

Following miscellaneous nozzles shall be provided for heat exchangers:

Vent drain (on either side); 1 ½" nozzle with blind flange for venting and draining shall be provided if exchanger is not getting vented / drained from process nozzle. Drain valve of adequate size (3" minimum) with spectacle blind to be provided on cooling water supply line downstream of isolation valve for back-flushing.

Multi-Purpose connections (50NB) are to be provided on all process nozzles.

All heat exchangers are to be provided with 3/4" utility connection on inlet and outlet nozzles of tube side and shell side for hydrotest purpose.

Thermo wells shall be provided at the inlet and outlet on both shell & tube side. For cooling water service it will be only on outlet.

Cooling water service exchangers shall be provided with an extra nozzle for chemical cleaning, where required.

9.7.6 Air Cooled Heat Exchangers'

Process Issues

Equipment design shall be based on final material balances with agreed overdesign margins. Physical properties used must have been validated.

Air cooled exchangers are preferably used over water cooled exchangers, wherever process conditions allow.

The preferred process temperature breakpoint between air and water cooling when air cooled exchange is followed by water cooled exchange is 55 ^{0}C.

For air coolers use 41 °C ambient air dry bulb temperature.

Sizing / Rating Issues

Proven rating calculations shall be used, documented and checked and verified.

The preferred process temperature breakpoint for all air cooled only exchanger evaluation is 11 ^{0}C above DBT.

Forced draft type fan to be provided. However, if the product outlet temperature less than 15 ^{0}C above the design air inlet temperature or low approach temperature below 12 ^{0}C or for corrosive services, induced draft shall be preferred.

Mechanical design

For air coolers the need for split headers shall be investigated in accordance with API 661 section 7.1.6.1.2. New equipment items should be in accordance with the codes and standards. Also split header shall be considered for inlet temp exceeding 180ºC. Tube specifications shall be as following

Material	Tube OD	Min. Thickness (minimum)
Carbon Steel / Low Alloy Steel	25	2.77 mm
Material SS / HAS .	25	2.11

Finned tubes shall be Aluminium – G-type embedded fin up to 400 ^{0}C (11 fins/inch). For design temp > 400 ^{0}C welded CS fins shall be used. Fin height of 12.7 mm is preferred.

Aluminium or UV resistant FRP (Moulded) type blades shall be used. Design to appropriately take into account static electricity concerns.

Electric motors for air cooled heat exchangers will be 100% direct-on-line type starters. VSD / dual speed motors shall be considered individually on merit.

9.7.7 Heaters

Process Issues + Sizing / Rating issues

Equipment design shall be based on final material balances with agreed overdesign margins. Physical properties used must have been validated.

Efficiency

Reasonably attainable heater efficiencies will vary with service, size of heater and quality of fuel.

Based on the net heating value of fuel, the typical minimum target fuel efficiency is 91-92% with air preheat & 89-90% minimum with steam generation for continuous operating heaters.

The basis for this fuel efficiency is 15% excess air for oil firing and 10% excess air for gas firing for the design case. The excess air can be lower with the low NOx burners. The monitoring will be through Oxygen analyzer at stack (target minimum 1.7% for gas firing and 2.5% for oil firing).

For the sizing of the heater, associated fans, ducting and air preheaters, higher level of excess air shall be considered (25% for oil firing and 15% for gas firing).

The efficiency figures can vary based on a number of factors and for a particular application, heater supplier will need to advice if efficiency improvement measures may not be justified in some case. The following table may be considered indicative only.

Sr.No.	Design feature	High heat duty furnaces	Medium heat duty furnaces	Low heat duty furnaces
1	Heat duty	Above 50 MMKcal/hr	5-50 MMkcal/hr	Less than 5 MMkcal /hr
2	Provide ID fan	Yes	Yes	No
3	Provide FD fan	Yes	No	No
4	VFD on FD fan (two fans, both may run at part load to avoid potential fuel rich condition in case of trip of one fan)	Yes	No	No
5	VFD on ID fan	No	No	No
6	% excess air	10-15 %	10-15%	15-20%
7	Provide O_2 analyser at the arch	Yes	Yes	Yes

Sr.No.	Design feature	High heat duty furnaces	Medium heat duty furnaces	Low heat duty furnaces
8	Provide CO analyser at the arch	Yes	Yes	No
9	Draft control	Automatic By acting on the stack damper	Automatic By acting on the stack damper	Manual acting on the stack damper
10	O_2 control	Automatic by acting on the VFD on the FD fan	Manual control	Manual control
11	Air preheater using Flue gas	Yes	No	No
12	Air preheater using steam u/s of Flue gas APH	No	No	No
13	MOC for flue gas APH	Optional - Superior metallurgy to take care of acid corrosion (e.g. glass)	Not applicable	Not applicable

Heat recovery

To achieve the target heater efficiency, Steam generation and Air Preheat is considered for the recovery of heat from the flue gas. See indicative table above.

Steam Generation in process heater convections is considered to be indirect steam generation and therefore can operate continuously for 2 years at a time.

Preheater type

Recuperative (stationary) type air preheater is normally used.

Combustion Air

Combustion air is to be supplied by a fan even when the air preheater is bypassed. Fan failure will result in shutdown of the heater.

A spare combustion air fan is specified (see note in table above abut need for simultaneous operation of spare fan).

A cold air bypass is provided for stack temperature control and for heater operation at 100% of normal duty with the air preheater bypassed.

Draft

A spare induced draft fan is not specified since the stack is considered to serve the purpose of a spare. If the induced draft fan fails, the air preheater bypass will open to divert flue gas to the stack.

NOx Emissions

Low NOx staged air burners are used for oil firing & Low NOx staged fuel burners are used for gas firing. The maximum NOx emission level shall be as per Indian statutory regulations.

Soot Blowers

Retractable soot blowers are installed in the convection coils wherever fuel oil firing or dual firing facility is available. MP Steam is used as the mobile carrier. For gas fired heaters space provision shall be made for future installation of soot blowers.

9.7.8 Rotating Equipment

9.7.8.1 Drives for critical rotary equipment

Critical service steam or power driven equipment is defined as equipment in that service which must be maintained in the event of power failure in order to protect personnel, equipment, or catalyst.

Critical equipment drive should be motor, with turbine driven spare, unless steam balance demands an extraction turbine for the main drive to avoid steam let down. Power is more reliable than Steam, as most of the steam comes from HRSG. For emergency steam, separate auxiliary boilers are to be provisioned. See also section 8.10.

Firewater pumps are 50% motor driven and 50% diesel engine driven. Spare lubricating circulation pump to critical equipment are motor driven.

9.7.8.2 Pumps

Process Issues

Equipment design shall be based on final material balances with agreed overdesign margins. Physical properties used must have been validated.

Shutoff head of pump is to be minimum 105 % of rated point for single operation and 110 % of rated point for parallel operation as far as possible. Shutoff head of centrifugal pump is to be preferably limited to 120 % of head at rated point.

The NPSHr shall be lower than NPSHa by at least 1m throughout the range from minimum continuous stable flow to the rated capacity unless the data sheet / Specification dictate otherwise states. NPSHa shall be reference to the bottom of the base frame for horizontal pumps; the suction nozzle centre line for vertical pumps, and top of the foundation for vertically suspended pumps.

The margins to be maintained between pump required and available NPSH values are defined in the Pump specifications.

Mechanical Design

In general, the centrifugal pumps should be selected from following four categories:

A. API Pumps

B. Non-API Pumps

C. Specially engineered pumps.

D. Seal-less pumps.

A. API Pumps:

API pumps should be selected for following applications / conditions:

- All pumps in hydrocarbon processing plants. This would also include pumps in non-hazardous services such as Phenolic water, wash water, etc.
- Pumps having high criticality with respect to safety. Failure / break down of the pump or its components may cause serious safety hazard to personnel, plant or environment. Examples of such services are concentrated acids, liquid containing Hydrogen Sulphide, liquids at and above auto ignition temperature etc.
- Pumps having high criticality with respect to reliability and availability. Non availability of the pump would result into significant production loss. Examples of such pumps are High pressure Coke cutting pumps, Boiler Feed Water pumps, Coker charge pumps, etc.

B. Non API pumps:

Non API pumps should be selected for the following applications /conditions:

- Centrifugal Pumps in non-critical services in chemical plants.
- Cooling tower pumps, DM plants, Fire Water, Sea Water, Waste water treatment applications, Fresh water, Desalination process pumps, Reverse Osmosis plant, Sodium Carbonate, Chemical effluents (Mixture of Alkaline & Acidic Liquids), etc.

C. Specially engineered pumps:

These pumps should be selected from standard and proven designs of vendors who have designed and developed these pumps for specific applications. Examples of such services are PTA slurry, FCCU column bottoms pumps, Coker plant Recirculation pumps, Coker Maze pit pump, etc.

Specially engineered pumps should be selected for the following service / condition:

- Services which require additional engineering inputs other than those in API specifications. Examples of such pumps are Coker Charge pumps with special features like auger type coke crusher etc.).

- Pumps in slurry applications. If the content of solid particles exceeds 20% by Volume, then the pumps should be designed as "Slurry Pumps".

D. Seal-less pumps

Seal-less Centrifugal pumps should be selected for services where absolute zero leakage from the shaft-casing interface is required, in view of safety considerations. Seal-less pumps can be either "canned motor pumps" or "magnetic drive pumps".

"Canned motor pumps" are used where safety of highest level is required and no leakage can be tolerated.

Typical seal-less pump services cover a broad range of fluids that include acids, alkalis, salts, corrosive fluids, esters, hydrocarbons, monomers, polymers, alcohols, ethers, halogens, nitrogen or sulfur compounds and even some extreme water conditions.

Seal-less pumps should conform to API 685.

Pumps will be normally unsheltered.

Start-up line and Recirculation line

For continuous duty pumps, the pump common suction line shall be sized for flows corresponding to all the pumps in operation to facilitate online testing of the standby pump without disturbing the process flow.

Minimum recirculation line

All pumps to have start up bypass through restriction orifice for testing.

- If driver motor power is greater than 50 HP, control valve with controller shall be used.
- If driver motor power is less than 50 HP, orifice shall be used.
- For low capacity pumps, this may be reviewed case to case basis.

Prevention of back flow overpressure:

- P lower than or equal 40 kg/cm^{2}g: one check valve.
- P higher than 40 kg/cm^{2}g and smaller than 80 kg/cm^{2}g: two check valves of different type (stem or shaft blow out resistant, preferably of the non-slamming type).
- P higher than or equal 80 kg/cm^{2}g: two check valves of different type (stem or shaft blow out resistant, preferably of the non-slamming type) plus an automatic shut-off valve in case of low flow.

Motor Ratings

Motors shall have power ratings including the service factor, if any, as below:

- For pumps with rated power < 22KW, motors shall be sized for at least 125% of the rated power requirement.
- For pumps with rated power equal to or greater than 22 KW, the following guidelines shall be followed:
    - For parallel operation, motor power shall at least equal to “end of curve” power requirement of the pump, or 115% of the pump power at rated conditions, whichever is greater.

9.7.8.3 Compressors

Equipment design shall be based on final material balances with agreed overdesign margins. Physical properties used must have been validated.

Mechanical design

Centrifugal and Axial compressors shall conform to API Standard 617. Driver selection will be evaluated for each application based upon process requirements, critical service, utilities, capital costs and appropriate shop test for axial or centrifugal compressors. Reciprocating compressor services for Process service shall be specified to conform to API Standard 618 with sufficient spare capacity to permit maintenance of one machine while the plant remains on stream.

Motor drivers will normally be specified. Screw compressors will be specified in special instances when determined to be advantageous over alternate choices. Screw compressors are specified to conform to API Standard 619. Driver selection is the same as indicated for centrifugal compressors.

9.8 Instrumentation

Instrumentation shall be as per the instrumentation specifications enclosed with the Requisition and Instrumentation Engineering Design Basis document EPCMD-1-ENGG-DBD-CI 0001.

9.8.1 General Requirements for instruments on Process P & IDs

All symbols in P& ID shall be as per ISA and as per the Symbology specified for this project.	Yes	
Sensor / transmitter for shutdowns separated from that for control / indication	Yes	
Solenoid valve operation with interlock shutdown system only	Yes	
Hand switches and status indication shall be in DCS only		No
Emergency / bypass switches shall be hardwired only		No
Shutdown signals shall be repeated in DCS	Yes	
Analog inputs for shutdown and interlocks shall be connected directly to ESD without use of receiver switch or trip amplifier.	Yes	
Instruments shall have individual tapping's from process lines except flow measurement using orifice as a flow element, wherein two pair of tapping shall be used for 4 transmitters (3 for shutdown and 1 for control)	Yes	
Remote stop push button shall be hard wired only	Yes	

Rotating equipment with auto start facility shall have Auto-manual switch in local.	Yes	
Indication of continuously running equipment on DCS	Yes	
Block and bypass valves to be provided for turbine meters, PD meters and mass flow meters.	Yes	
2 out of 3 voting required for critical trip interlocks.	Yes	

Gas detectors, linear heat detectors for floating roof tanks, ROR heat detectors for clean agent system shall be provided for process units and OSBL facilities as per provisions of OISD-116. Interlock for operating Fire Water / agent system shall also be provided.

Instrument impulse lines to be insulated / traced, wherever required, to avoid congealing, condensation.

Cooling tower fan to have vibration monitoring system with control room indication

Cooling tower fans shall have stop switch at grade level.

9.8.2 Standard Utility Line Instrumentation

The following table will be populated in discussion with the process licensor.

Utility	Local PI	DCS PI	PAL/ PAH	Local TI	DCS TI	TAL / TAH	DCS FI	FAL / FAH	DCS FQ
MP Steam									
LP steam									
Condensate									
CW supply									
CW Return									
Instrument Air									
Plant Air									
Inert Gas									
Fuel gas									
Fuel Oil									
DM Water									

Utility	Local PI	DCS PI	PAL/ PAH	Local TI	DCS TI	TAL / TAH	DCS FI	FAL / FAH	DCS FQ
Service Water									
Flare									
Fire Water									

9.9 Piping related guidelines

9.9.1 Engineering Design Basis

Design of piping systems shall be in line with Piping Specifications and other related Engineering Design Basis document EPCMD-1-ENGG-DBD-PP-001.

9.9.2 Hydraulics calculation basis

All critical circuits will be checked against actual piping configurations and against as purchased equipment.

Refer to section 8.2 for guidelines on sizing of Utilities distribution headers.

9.9.3 Control Valve manifold

As a default, control valve up to 8” size and in steam service for all sizes, shall be provided with a manifold of block and bypass valves. Bypass valve shall be globe valve. For control valve higher than 8" size bypass if required, shall be butterfly or gate valve, depending on service. Size of bypass valve will be as per equivalent Cv of control valve. Control valves not having block and bypass provision shall be provided with hand wheel for manual operation. Control valves isolation and bypass valves shall be as per ISA standard.

Control valve bypass valves in critical services where, for all sizes, the bypass valve will be tagged on P & IDs, be of same construction and CV as the control valve and operated through HICs. Such valves shall be in the scope of Instruments engineering to procure and not in scope of Piping engineering group to procure.

All Control valves shall be provided with ¾” drain valves for maintenance purpose which can be provided at upstream or downstream of the control valve based on the P&IDs".

Where the service requires precise control at all points in time (for example during Control valve maintenance), the bypass valve in the control valve assembly need to be a valve of same construction (body and trim) as the control valve with manually operated actuator (from control room). Such valves shall be identified on the P & IDs and shall be procured by Instruments.

9.9.4 Specific technical requirements

- OWS piping shall be underground in ISBL and OSBL till collection pit; thereafter it is pumped to ETP through above ground lines.
- Blowdown lines can be underground or above ground depending on service. For C4 service where the line is pressurized, blowdown lines can be above ground in OSBL.
- All pipelines except fire water and cooling water greater than 24" OD shall be above ground in OSBL.
- Hydrocarbon lines shall run above ground.
- Pipe of sizes 1 ¼", 2 ½", 3 ½", 5" and 9" shall not be used.
- All drain valves should be flanged with positive isolation to prevent accidental leakages.
- Fire water hydrant riser will have isolation valve at grade.
- All headers at battery limit will have isolation valve with spectacle blind and drain valves at each side.
- Licensor recommendation will be followed for spare header in fouling/choking service and for providing breakup flanges in piping headers at certain distances and will have minimum bends.
- All drain valves in piping to have sufficient distance from grade to provide temporary hose connection for decommissioning and flushing purposes.
- All process piping shall be as per ANSI B31.3 and steam; condensate and feed water lines shall be as per IBR / ANSI B31.3 as applicable.

9.10 Electrical system design related guidelines

Electrical system design shall be in line with the Electrical System Design Basis document EPCMD-1-ENGG-DBD-EL-001.

10 Safety, health and environment related requirements

10.1 Hazardous properties of Chemicals

Reliance has standardised Globally Harmonized System of compiling and reporting the hazardous properties of chemicals. The same practice shall be adopted for all projects. For many common chemicals, Reliance is in a position to extract the data from already compiled database and the same cane be adopted for project with requisite verification by licensor / BEC.

10.2 Chemical Chemical Interaction Matrix

Reliance requires Licensor / BEC and later DEC also to compile and present detailed chemical chemical interaction matrix. The service list needs to include all utilities, small quantity chemicals and atmospheric air. Standard risks associated with fire, explosion, various chemical reactions, toxicity and others shall be highlighted.

Reliance has developed such matrices for all manufacturing installations and these can cover most of the chemical chemical interactions foreseen for various projects.

10.3 Chemical Metal Interaction Matrix

Licensor / BEC / DEC and Vendors shall take cognizance of all normal operation Chemical Metal Interactions. This information shall be compiled and formalised in a matrix form and shall. Material Selection Diagram at basic design stage and actual metallurgy selection by DEC and Vendors shall be guided by the Chemical Metal Interaction Matrix.

10.4 Management of highly toxic materials

Licensor / BEC / DEC and vendors shall be guided by Reliance Safety Standards about management of highly toxic materials. This document provides list of highly toxic materials and specific recommendations on handling and storing of these.

10.5 Inherently safer process design approaches

Reliance plans to progressively adopt inherently safer process design approaches. These will follow principles of Elimination, Substitution, Inventory reduction and Process intensification and Moderation. Licensor and BEC are required to actively utilize such principles without compromising the design objectives of the plant. At the simplest level, this can be a check-list based audit that can identify safer options.

At a more comprehensive level, more formal tools can be used where the risks justify use of detailed methodology.

10.6 Hazard identification

Reliance is adopting semi-quantitative methods of identifying and categorizing process hazards based on computation of various indices.

Some typical indices are Dow Fire & Explosion index, Chemical Exposure Index, Mond Index, Safety and Health Index and several others. It is required that Licensor / BEC / Vendor carry out such analysis for the process plants.

10.7 HAZOPS

HAZOPS are required for all the new facilities at Reliance including all packages. All the inter- connections with existing facilities are to be studied critically, identifying the potential impacts of incidents at either end of the interconnects.

HAZOPS shall take cognizance of GHS format data, Chemical Chemical Interaction Matrix data, Chemical Metal Interaction Matrix data, Hazard identification studies. HAZOPS shall use a Risk Assessment Matrix advised by Reliance. It is required that this be uniform across all projects for a leadership team to moderate the recommendations conveniently and quickly.

For technologies that are relatively new to Reliance, HAZOPS or similar studies shall be carried out at Licensor's / BEC's premises during evolution of Basis engineering design.

This is in addition to HAZOPS to be carried out during detail engineering. For rest of the units, one HAZOPS at DEC's premises, with 30 to 40% progress in engineering shall suffice.

Package vendors shall carry out HAZOPS following same guidelines, practices and work instructions. PMT shall ensure compliance through respective DEC's.

All HAZOPS recommendations shall be reviewed by a leadership tem for moderation and the approved changes shall be tracked for implementation.

10.8 SIL Assessment studies

HAZOPS at Licensor's / BEC's premises shall be followed by a SIL Assessment study. For such study, it is convenient to have the ESD systems defined.

If this exercise is not complete during Basic engineering, the SIL Assessment study shall be carried out at DEC's premises once the first pass ESD definition is complete.

As in case of HAZOPS, a leadership team shall moderate the SIL Assessment recommendations and shortlist the ones to be implemented. These shall be tracked and liquidated by respective DEC's and Vendors. PMT shall ensure compliance.

10.9 Risk Analysis

Quantitative Risk analysis shall be carried out for facility siting and development of overall plot plan. For this purpose, PHAST, PHASTRISK and equivalent software shall be utilized. Risk shall be analysed for major single events in isolation.

IR shall be calculated for most exposed (to process risk) employees and computed IR shall be compared with Policy IR. Licensor / BEC shall advise failure data to be utilized for QRA based on their experience. The ALARP principle shall be adopted in making choices about risk mitigation measures.

10.10 Development of plot plan

Special recommendations from Licensor, if any, are to be incorporated for development of Unit layout and Overall plot plan as relevant. The plot plan shall follow norms / guidelines of latest issue of Oil Industry Safety Directorate as a minimum. Depending on the capacities of plants involved, it would be advisable for the J3 project team to refer to guidelines available from IRI, GE Gap 2.5.2 and such others. Optimum spacing will be provided for ease of Operation / Maintenance for critical equipment layout. Area classification requirements as per relevant Indian Standard must be followed.

Over and above, Maximum Consequence Analysis results and QRA results shall be taken in consideration while developing the overall plot plan.

10.10.1 Baseline data for pollutants and dispersion modeling

MOEF has stipulated maximum ground level concentrations of various chemicals that can be allowed for a location. These have been fixed based on the effect of these chemicals on health of human beings and in some cases on flora and fauna.

For the J3 project sites, baseline data on GLCs shall be available through a separate study. For all new potential emissions, dispersion analysis shall be carried out initially for project clearance, (beyond RPMG scope) and later in course of detail engineering.

This study can have impacts on the locations of individual stacks and hence on the overall plot plan.

10.11 Typical safety features

The following sections in this document describe some of the key safety features typically utilized in linear installations.

10.11.1 For prevention

Safety facilities for prevention shall normally include the following:

- Basic Process Control System
- Design of DCS system with sufficient redundancies
- ESD systems for protection of process systems including packages
- Segregation between DCS and ESD systems, ideally no components are to be shared for ESDs protecting high risk events
- Fault tolerant architecture for ESD system
- Reliability of power supply systems
- Reliability of UPS system
- SIL assignment and verification studies
- Provision of Partial stroke Testing Devices on critical shut-down valves
- Designs with low potentials for spurious trips
- Close loop sampling for Liquid and Gaseous streams based on Licensor philosophy.
- Provision of back flow prevention devices as required.
- Standard Maintenance Procedures
- Standard Operating Procedures
- Operator intervention in contingencies

10.11.2 For containment of incident impact

Safety facilities for incident containment shall normally include the following:

- Safe/close loop discharge of Relief / vent system in plant (including all hydrocarbons and ammonia system) based on Licensor philosophy
- Provision of remote isolation valve
- Provisioning of PSVs / Ruptures disks or combinations of adequate capacity.
- A complex-wide combined Fire & Gas detection system shall be provided.
- All F & G alarms shall be available in the control room, fire stations, Site Shift Manager's office and other strategic locations.
- A detailed F & G detection / provision matrix shall be prepared for the complex. This will cover which type of detectors will be used and where those will be installed.
- F & G system will have integrations with systems mentioned below as a minimum :
  - Deluge system
  - Public Address system and CCTV
  - Extinguishant skid (clean agent extinguishant gas)
  - Fire hydrant / Fire water ring main header system / panel
  - Gas Turbine system
  - HVAC system
  - ESD systems as per Licensor's recommendations / SIL verification study recommendations
- Fire water Network
- Fire Extinguishers, Fire Monitors and Deluge system

10.11.2.1 Provisioning of Pressure Relief Valves

PSVs will be installed on all vessels, columns, reactors and similar equipment or connected piping. These PSVs can discharge to different headers depending on the process conditions.

For J3 projects the superimposed back-pressure is to be determined for the different headers for sizing of pressure relief valve.

For built up back pressure up to 10% of set pressure for conventional design and 50% of set pressure for balanced bellows.

On sphere and bullet under PESO approval, two independent safety valves with separate inlet nozzle shall be provided. Each safety valve shall be sized to relieve full capacity. Preferences towards pressure relief valves shall be as follows:

PSV for operational failures shall have installed spare (at least one spare to be provided for multiple PSV)	Yes	
PSV exclusively for non-operational failures (external fire or heat exchanger tube rupture) shall not have installed spare	Yes	
PSV in IBR steam service shall have upstream / downstream isolation		No
PSV in air service shall have only upstream isolation	Yes	
PSV for thermal relief valve shall not have installed spare	Yes	
PSV on spare equipment shall have downstream isolation only if connected to closed system:	Yes	
Spared PSV shall have upstream , and downstream isolation	Yes	
Spared PSVs open to atmosphere shall have only upstream isolation (LO)	Yes	
Unspared PSV shall have isolation valve	Lock closed	
For steam services, IBR shall be followed for safety valve sizing	Yes	

10.11.2.2 Blow-down and Flare

Pressure relief valve in hydrocarbon vapour services and hydrocarbon liquid services shall discharge to a close relief header routed to a knock out drum and flare. Knock out drum shall be provided at the battery limit of each ISBL unit.

All hydrocarbon liquid drains from equipment shall have connection to CBD as well as to OWS. Oily water drains shall not be combined with rain water collection system. However, within the paved area of the unit rain water is likely to be contaminated with oil and can be discharged in the oil drains. The balance, rain water shall drain off to the surface rain water System.

10.11.2.3 Handling toxic blow-down streams

The design requirements presented below are applicable for all process streams containing:

- 0.1 % (weight) or more benzene
- or 25% (weight) or more C6 through C9 aromatics,
- Hydrogen sulphide, Chlorine, Amines etc. as per definitions of highly toxic materials.

Water streams saturated with toxic chemicals are required to be directed to suitable locations within the process whenever possible or to appropriate other processing or treating facilities in order to minimize toxic chemicals emissions to the environment.

Typically, a closed, toxics collection system is required, to which the following are piped a) Vessel drains; b) Control valve drains; c) Gauge glass/level instrument drains; d) Pump drains; e) Other equipment where sparing and / or valving are provided for routine maintenance and equipment removal. Closed, flow-through sample containers are used. Pumps are equipped with dual seals and suitable barrier fluid systems. Seals are double or tandem depending upon process requirements.

10.11.3 For emergency handling

- Sufficient facilities shall be provided adjacent to the work areas to permit reasonable access from all areas of potential hazards to the operator and maintenance team
- Safety showers and eye wash
- Temporary Safe havens
- Emergency Lighting back up
- Exit from units shall be provided wherever necessary for emergency exit.
- Manual Call Points (MCP)
- Assembly point shall be marked for each unit
- Emergency light Coding (Blue, Red Yellow)
- Public Announcement System (Emergency communication system) in plant

10.12 Environmental compliance

A project specific Environmental Design Guideline for J3 projects shall be evolved in line with latest guidelines from Ministry of Environment and Forests.

10.12.1BAT Analysis

It is required that for all affected sources, a Best Available Technology Not Entailing Excessive Cost (BATNEEC) analysis must be provided. BATNEEC means achieving an emission or discharge based on the maximum degree of reduction for pollutants, which is at least as stringent as the MOEF standards.

This shall be achieved by application of production processes or available methods / technologies, operational practices, systems and techniques taking into account energy, environmental and economic impacts and other costs to the facility. The preferred pollution control methodology proposed by the BATNEEC analysis shall as a minimum meet all applicable MOEF standards and requirements.

10.12.2 Typical provisions for environmental monitoring

- Project procedure shall be evolved and followed for fugitive emissions pertaining to control valves and mechanical valves. .
- GC based Air ambient monitoring system for fugitive emission monitoring to be provided as required by the statutory requirements and latest safety standards.
- Monitoring of particulate matter on-line may require non-GC equipment.

10.12.3 Noise level limitation

- Unless otherwise specified in project procedures the purchased equipment and final plant design are usually governed by the noise level exposure limitations of OSHA.

11 Documentation Requirements

11.1 Equipment Numbering

The Equipment numbering and component identification shall be as per Project Procedure Documents J3-PCP-08-006-00.

11.2 Documentation and Document Numbering

All documentation should be prepared on International Standards Organization, (ISO), standard paper sizes (i.e. A1, A2, A3, A4 etc.).

The Drawing and Document numbering shall be as per Project procedure document J3-PCP-08-005-00.

12 Review and Closure

The minimum information required as per formats attached with this document is mandatory. However, the representation format can be altered with prior approval of Owner.

12.1 Reliance's review requirements

Reliance team of specialists would conduct reviews and audits of engineering carried out for all Reliance projects. The details of such reviews conducted for a typical project shall vary from activity to activity and the criticality of application.

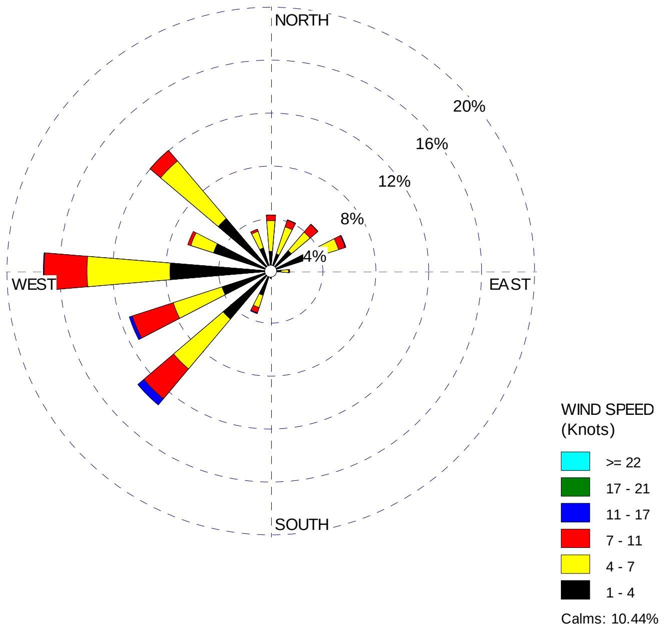
The reviews would aim at quality assurance without sacrificing productivity or schedule. PMT team on the project will remain available for consultation on specific technical issues, where the consultants / vendor's teams may be in need of technical support or guidance.

12.2 Accountability

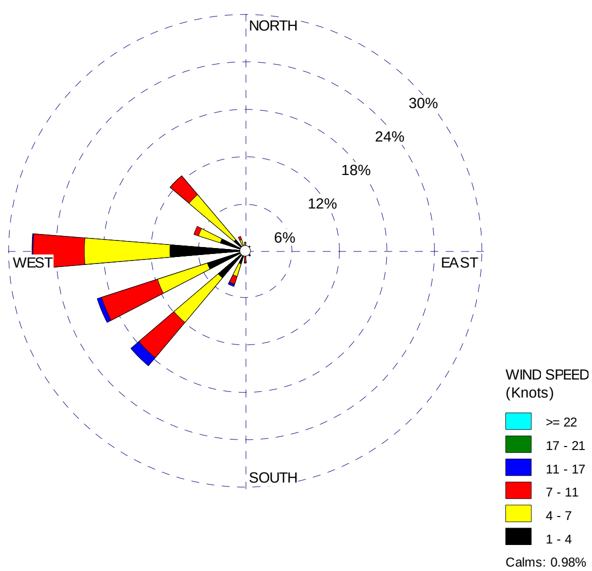
Respective Consultants shall be fully responsible and accountable for areas of work delivered by them or information material added by them to complete a task. In case, the Consultant / Vendor arrange the work to be done through a third party, back to back guarantees shall be arranged and both parties shall be jointly accountable.

ATTACHMENT 1 - Wind Roses at Jamnagar site

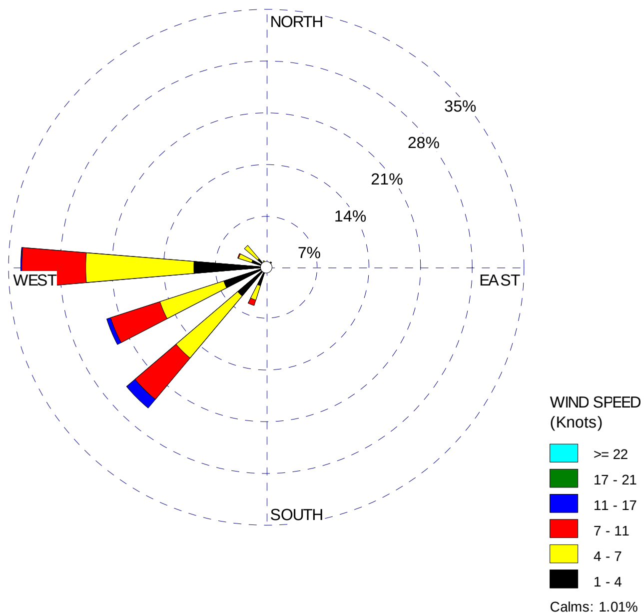
Annual (all months)



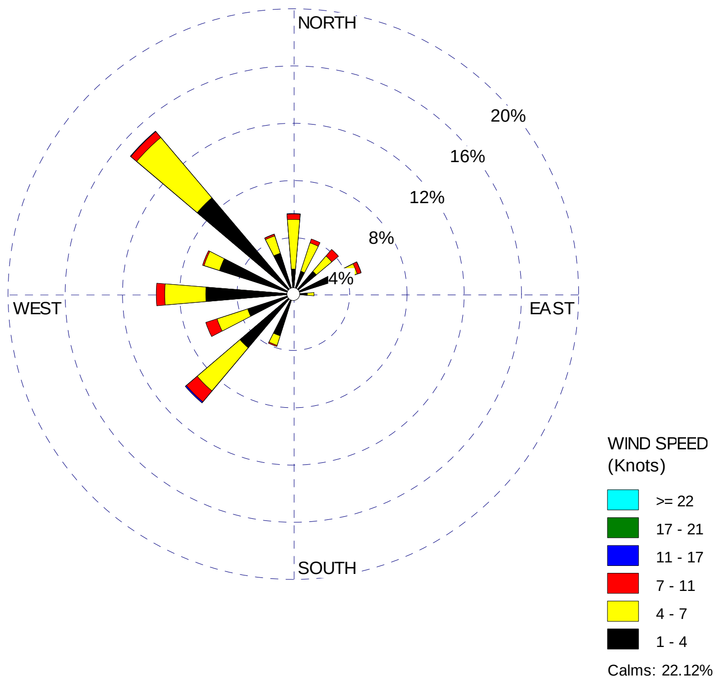
Summer (Apr. – Jun)



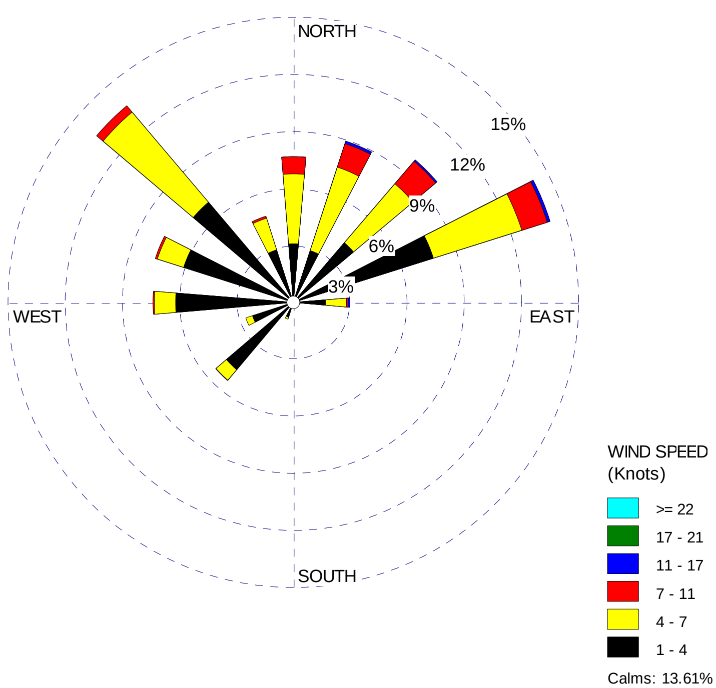
Monsoon (July – Aug.)



Post Monsoon (Sep. – Nov.)



Winter (Dec. – Mar.)



ATTACHMENT 2 - Utilities Qualities and Test Methods

UTILITIES QUALITIES AND TEST METHODS

ATTACHMENT 2

TO

EPCMD-1-DBD-GE-001

BEDD FOR J3 PROJECTS

RELIANCE

Notes

1. Preliminary Quality Specification available from various process units have been studied. The numbers in this document, though preliminary, do not appear to have disconnects with process unit requirements.

Rev	Date	Description	By	Checked	Approved
1	20.06.12.	Revised and updated	SM	SM	SM / KMB
0	21.05.2012	Issued for Licensor KOM	SB/ PS	SM	SM

QUALITY OF RAW WATER				
Sr.No	**Parameters**	**Testing Method**	**Unit**	**Specification (See Sheet on Desalinated Water)**
1	pH	IS 3025 P-11	—	8.3
2	Turbidity	IS 3025 P-10	NTU	6.7
3	TDS	IS 3025 P-16	ppm	202
4	TSS	IS 3025 P-17	ppm	
5	Total Silica as SiO_2	ASTM D 859	ppm	
6	Colloidal Silica as SiO_2	ASTM D 859	ppm	
7	Sulphate as SO4	IS 3025 P-24	ppm	23
8	Total Iron	APHA-3500 Fe B	ppm	< 0.1
9	Chloride as Cl	IS 3025 P-32	ppm	29
10	Copper	IS 3025 P-42	ppm	
11	Organic matter as $KMnO_4$	Note 3		
12	Total Hardness as $CaCO_3$	IS 3025 P-21	ppm	122
13	Calcium Hardness as $CaCO_3$	IS 3025 P-21	ppm	79
14	M - Alkalinity as $CaCO_3$	APHA-2320 B	ppm	120
15	Magnesium	IS 3025 P-21	ppm	43

NOTES

1. Raw water will be primarily obtained from Sea Water RO units. The quality of water can be seen in the sheet for Desalinated water. This sheet indicates quality of water currently used for miscellaneous purposes in DTA nd SEZ refineries, as per communication received from Jamnagar on 22.05.12.

~~2. IS 3025~~

2. Attachment 2 to BEDD EPCMD-1-DBD-GE-001 dated 20.06.12

3. Traditionally TOC is right indicator, however KMnO4 Number may also be considered.

1	20.06.12.	Note 2	SM	SM	SM / KMB
0	21.05.12	Note 2 ~~3~~	SB / PS	SM	SM
Rev	**Date**	**Description**	**By**	**Checked**	**Approved**

QUALITY OF SEA WATER

Sr.No	Parameters	Testing Method	Unit	Specification
1	pH	IS 3025 P-11	—	7.5 - 8.0
2	Normal Supply Temperature	IS 3025 P-9	^{o}C	25 - 35
3	TDS	IS 3025 P-16	ppm w/w	42000
4	TSS	IS 3025 P-17	ppm w/w	20
5	Calcium Hardness as $CaCO_3$	IS 3025 P-21	ppm w/w	461
6	Total Alkalinity as $CaCO_3$	APHA-2320 B	ppm w/w	125
7	Magnesium	IS 3025 P-21	ppm w/w	1422
8	Sulphate	IS 3025 P-24	ppm w/w	2500
9	Sulphide	IS 3025 P-29	ppm w/w	Nil
10	Ammonia	IS 3025 P-34	ppm w/w	Nil
11	Residual Chlorine	4500-Cl A	ppm w/w	0. 1 - 0.3
12	Free Oil	Can be determined by O & G Analyzer - APHA 5220B	ppm w/w	0.015
13	Phenol	ASTM D1783	ppm w/w	Nil
14	BOD_5	APHA 5210 D / IS 3025 P-44	ppm w/w	20

NOTES

1. To be confirmed from Jamnagar based on latest data (seasonal variation in turbidity, design turbidity for Desal unit).

~~2. To be confirmed~~

2. Attachment 2 to BEDD EPCMD-1-DBD-GE-001 dated 20.06.12.

Rev	Date	Description	By	Checked	Approved
1	20.06.12.	Note 2	SM	SM	SM/KMB
0	21.05.12	Note 2 ~~3~~	SB / PS	SM	SM

QUALITY OF DSW FROM THERMAL DESAL UNITS IN DTA AND SEZ REFINERIES

Sr.No	Parameters	Testing Method	Unit	Specification
1	pH	IS 3025 P-11	—	5.5 - 7
2	Normal Supply Temperature	IS 3025 P-9	^{o}C	40 - 45
3	Conductivity	ASTM D1125	µS /cm	<= 15
4	TDS	IS 3025 P-16	ppm w/w	< 10
5	TSS	IS 3025 P-17	ppm w/w	Nil
6	Silica	ASTM D 859	ppm w/w	< 0.02
7	Sodium	AAS (PE Application note)	ppm w/w	< 2
8	p-Alkalinity ~~NaOH~~	APHA 2320B	ppm w/w	Nil
9	Iron	APHA-3500 Fe B	ppm w/w	< 0.1
10	Copper	IS 3025 P-42	ppm w/w	< 0.005
11	Sulphate	IS 3025 P-24	ppm w/w	< 1
12	Chloride	IS 3025 P-32	ppm w/w	< 2
13	Residual Chlorine	4500-Cl A	ppm w/w	Nil
14	Total Hardness as $CaCO_3$	IS 3025 P-21	ppm w/w	<0.1
15	Total Alkalinity as $CaCO_3$	APHA-2320 B	ppm w/w	<2
16	Calcium as $CaCO_3$	IS 3025 P-21	ppm w/w	< 0.1
17	Dissolved Oxygen (DO)	ASTM D888	ppb	-
18	TOC	APHA-5310 B	ppm w/w	-

NOTES

1. Preferentially routed to DM water system / process water system make-up use.

~~2. To be confirmed~~

2. Attachment 2 to BEDD EPCMD-1-DBD-GE-001 dated 20.06.12.

1	20.06.12.	Note 2 3	SM	SM	SM / KMB
0	21.05.12	Note 2 ~~3~~	SB / PS	SM	SM
Rev	**Date**	**Description**	**By**	**Checked**	**Approved**

QUALITY OF DESALINATED WATER FROM RO UNITS IN J3 COMPLEX				
Sr.No	**Parameters**	**Testing Method**	**Unit**	**Specification**
1	pH	IS 3025 P-11	—	7.2 - 8.2
2	Normal Supply Temperature	IS 3025 P-9	^oC	Ambient
3	Conductivity	ASTM D1125	µS /cm	
4	TDS	IS 3025 P-16	ppm w/w	< 10
5	TSS	IS 3025 P-17	ppm w/w	Nil
6	Silica	ASTM D 859	ppm w/w	< 0.01
7	Sodium	AAS (PE Application note)	ppm w/w	
8	p-Alkalinity ~~NaOH~~	APHA 2320B	ppm w/w	
9	Iron	APHA-3500 Fe B	ppm w/w	
10	Copper	IS 3025 P-42	ppm w/w	
11	Sulphate	IS 3025 P-24	ppm w/w	
12	Chloride	IS 3025 P-32	ppm w/w	Approx 5
13	Residual Chlorine	4500-Cl A	ppm w/w	
14	Total Hardness as $CaCO_3$	IS 3025 P-21	ppm w/w	
15	Total Alkalinity as $CaCO_3$	APHA-2320 B	ppm w/w	
16	Calcium as $CaCO_3$	IS 3025 P-21	ppm w/w	
17	Dissolved Oxygen (DO)	ASTM D888	ppb	
18	TOC	APHA-5310 B	ppm w/w	Nil

NOTES

1. To be further evolved during facility design.

2. Attachment 2 to BEDD EPCMD-1-DBD-GE-001 dated 20.06.12.

0	20.06.12.	Note 2	SM	SM	SM / KMB
Rev	**Date**	**Description**	**By**	**Checked**	**Approved**

QUALITY OF CIRCULATING COOLING WATER

Sr.No	Parameters	Testing Method	Unit	Specification
1	pH	IS 3025 P-11	—	6.8 -7.8
2	Conductivity	ASTM D1125	µS/cm	<=2000
3	Calcium Hardness as CaCO3	IS 3025 P-21	ppm	75 - 125
4	M - Alkalinity as $CaCO_3$	APHA-2320 B	ppm	<=250
5	Ortho Phosphate as PO_4 U / F	APHA-4500-P D	ppm	11 - 20
6	Sol. Ortho Phosphate as PO_4	APHA-4500-P D	ppm	11 - 17
7	Delta Phosphate as PO_4	APHA-4500-P D	ppm	<=3
8	Zinc	AAS (PE Application note)	ppm	0.5 - 1.5
9	Iron	APHA-3500 Fe B	ppm	<=2
10	Turbidity	IS 3025 P-10	NTU	<20
11	Free Residual Chlorine	4500-Cl A	ppm	0.2 - 0.5
12	TSS	IS 3025 P-17	ppm	<25
13	Chlorides	IS 3025 P-32	ppm	<500
14	Copper	IS 3025 P-42	ppm	<0.05
15	Active Dispersant polymer	Chemical Specific	ppm	20 - 25
16	SRB	Bactaslyde	Org./100 ml	10

NOTES

1. Cooling water quality specified is indicative only. It will be a function of design of cooling tower , make up water quality and method of water treatment. Furnished figures are indicative and typical of DTA and SEZ refineries.

~~2. To be confirmed~~

2. Attachment 2 to BEDD EPCMD-1-DBD-GE-001 dated 20.06.12.

1	20.06.12.	Note 2	SM	SM	SM / KMB
0	21.05.12	Note 2 ~~3~~	SB / PS	SM	SM
Rev	**Date**	**Description**	**By**	**Checked**	**Approved**

QUALITY OF COOLING TOWER MAKE-UP WATER

Sr.No	Parameters	Testing Method	Unit	Specification	
				High TDS Treated Effluent	Low TDS Treated Effluent
1	pH	IS 3025 P-11	—	6 - 8	6.5 - 8
2	Normal supply Temperature	IS 3025 P-9	^0C	20 - 40	20 - 40
3	TDS	IS 3025 P-16	ppm w/w	1500 - 3000	<500 (mainly sodium chloride)
4	TSS	IS 3025 P-17	ppm w/w	20 - 50	5
5	Calcium as $CaCO_3$	IS 3025 P-21	ppm w/w	Low	Low
6	Total Alkalinity as $CaCO_3$	APHA-2320 B	ppm w/w	50 - 200	Low
7	Magnesium	IS 3025 P-21	ppm w/w	Low	Low
8	Sulphate as SO4	IS 3025 P-24	ppm w/w	50 - 200	Low
9	Sulphide	IS 3025 P-29	ppm w/w	1	1
10	Ammonia	IS 3025 P-34	ppm w/w	10 - 50	5
11	Total Silica as SiO_2	ASTM D 859	ppm w/w	-	-
12	Residual Chlorine	4500-Cl A	ppm w/w	0.1 - 0.3	0.1 - 0.3
13	Total Iron	APHA-3500 Fe B	ppm w/w	-	-
14	Copper	IS 3025 P-42	ppm w/w	-	-
15	Free Oil	Can be determined by O & G Analyzer - APHA 5220B	ppm w/w	<20	<10
16	Phenol	ASTM D1783	ppm w/w	0.1	1
17	BOD_5	APHA 5210 D / IS 3025 P-44	ppm w/w	<100	20

NOTES

1. Make up water quality may vary for specific cooling Tower system (Desalinated water / Sea water).
2. Make up water can be Raw Water, Desalinated Water, ~~condensate~~ , Low TDS treated effluent or High TDS treated Effluent (depending on the characteristics of J3 complex treated effluent - quality yet to evolve), and as such quality may vary. Low and High TDS water qualities based on current experience. J3 Project figures to be evolved by OSBL designer.

~~3. To be confirmed.~~

3. Attachment 2 to BEDD EPCMD-1-DBD-GE-001 dated 20.06.12.

Rev	Date	Description	By	Checked	Approved
1	20.06.12.	Note 2	SM	SM	SM / KMB
0	21.05.12	Note 3 4	SB / PS	SM	SM

QUALITY OF DEMINERALIZED WATER				
Sr.No	**Parameters**	**Testing Method**	**Unit**	**Specification**
1	pH	IS 3025 P-11	—	6.5 - 7.5
2	Conductivity	ASTM D1125	µS/cm	< 0.15
3	TDS	IS 3025 P-16	ppm w/w	< 0.1
4	TSS	IS 3025 P-17	ppm w/w	Nil
5	Silica	ICP	ppm w/w	< 0.01
6	Sodium	ICP	ppm w/w	< 0.01
7	p-Alkalinity ~~NaOH~~	APHA 2320B	ppm w/w	< 0.01
8	Iron	APHA-3500 Fe B / ICP	ppm w/w	< 0.02
9	Copper	ICP	ppm w/w	0.003
10	Sulphate	IS 3025 P-24	ppm w/w	Nil
11	Chloride	IS 3025 P-32	ppm w/w	Nil
12	Residual Chlorine	4500-Cl A	ppm w/w	Nil
13	Total Hardness as $CaCO_3$	IS 3025 P-21	ppm w/w	Nil
14	Total Alkalinity as $CaCO_3$	APHA-2320 B	ppm w/w	Nil
15	Calcium as $CaCO_3$	IS 3025 P-21	ppm w/w	Nil
16	Dissolved Oxygen (DO)	ASTM D888	ppb	-
17	TOC	APHA-5310 B*	ppm w/w	-

NOTES

1. To be verified during facility design basis finalization

~~2. To be confirmed~~

2. Attachment 2 to BEDD EPCMD-1-DBD-GE-001 dated 20.06.12.

* Method detection limit is 1.0 ppm

1	20.06.12.	Note 2	SM	SM	SM / KMB
0	21.05.12	Note 2 ~~3~~	SB / PS	SM	SM
Rev	**Date**	**Description**	**By**	**Checked**	**Approved**

QUALITY OF HIGH HIGH PRESSURE (HHP) BOILER FEED WATER				
Sr.No	**Parameters**	**Testing Method**	**Unit**	**Specification**
1	pH	IS 3025 P-11	—	8.5 - 9.5
2	Conductivity	ASTM D1125	µS/cm	< 0.15
3	TDS	IS 3025 P-16	ppm w/w	< 0.1
4	TSS	IS 3025 P-17	ppm w/w	Nil
5	Silica	ICP	ppm w/w	< 0.01
6	Sodium	ICP	ppm w/w	< 0.01
7	Sulphate	IS 3025 P-24	ppm w/w	Nil
8	Iron	APHA-3500 Fe B / ICP	ppm w/w	<0.02
9	Copper	ICP	ppm w/w	< 0.003
10	Chloride	Ion-Chromatography	ppm w/w	<0.1
11	Residual Chlorine	4500-Cl A	ppm w/w	Nil
12	Total Hardness as $CaCO_3$	IS 3025 P-21	ppm w/w	Nil
13	Total Alkalinity as $CaCO_3$	APHA-2320 B	ppm w/w	Nil
14	Calcium as $CaCO_3$	IS 3025 P-21	ppm w/w	Nil
15	Dissolved Oxygen (DO)	ASTM D888	ppb w/w	< 7.0
16	TOC	APHA-5310 B*	ppm w/w	<= 1
17	Residual N_2H_4		ppm w/w	Above traces
18	Oil Content		ppm w/w	0.2 max

NOTES

1. To be verified during facility design basis finalization.

~~2. To be confirmed.~~

2. Attachment 2 to BEDD EPCMD-1-DBD-GE-001 dated 20.06.12

* Method detection limit is 1.0 ppm

1	20.06.12.	Note 2	SM	SM	SM / KMB
0	21.05.12	Note 2	SB / PS	SM	SM
Rev	**Date**	**Description**	**By**	**Checked**	**Approved**

QUALITY OF BOILER FEED WATER (HP,MP and LP)				
Sr.No	**Parameters**	**Testing Method (Note 2)**	**Unit**	**Specification**
1	pH	IS 3025 P-11	—	8.8 - 9.5
2	Conductivity	ASTM D1125	µS/cm	< 0.15
3	TDS	IS 3025 P-16	ppm w/w	< 0.1
4	TSS	IS 3025 P-17	ppm w/w	Nil
5	Silica	ICP	ppm w/w	< 0.01
6	Sodium	ICP	ppm w/w	< 0.01
7	Sulphate	IS 3025 P-24	ppm w/w	Nil
8	Iron	ICP	ppm w/w	<0.02
9	Copper	ICP	ppm w/w	<0.003
10	Chloride	Ion-Chromatography	ppm w/w	<0.1
11	Residual Chlorine	4500-Cl A	ppm w/w	Nil
12	Total Hardness as $CaCO_3$	IS 3025 P-21	ppm w/w	Nil
13	Total Alkalinity as $CaCO_3$	APHA-2320 B	ppm w/w	Nil
14	Calcium as $CaCO_3$	IS 3025 P-21	ppm w/w	Nil
15	Dissolved Oxygen (DO)	ASTM D888	ppb w/w	<7.0
16	TOC	APHA-5310 B*	ppm w/w	< = 1
17	Residual N_2H_4		ppm w/w	Above traces

NOTES

1. To be verified during facility design basis finalization.

~~2. To be confirmed.~~

2. Attachment 2 to BEDD EPCMD-1-DBD-GE-001 dated 20.06.12.

3. CPP may require BFW at a pressure intermediate between HHP and HP

* Method detection limit is 1.0 ppm

1	20.06.12.	Note 2	SM	SM	SM / KMB
0	21.05.12	Note 2 ~~3~~	SB / PS	SM	SM
Rev	**Date**	**Description**	**By**	**Checked**	**Approved**

QUALITY OF FIRE WATER

Sr.No	Parameters	Testing Method	Unit	Specification (Note 1)
1	Normal Supply temperature	IS 3025 P-9	^{o}C	
2	pH	IS 3025 P-11	—	
3	Conductivity	ASTM D1125	µ mhos/cm	
4	Turbidity	IS 3025 P-10	NTU	
5	TDS	IS 3025 P-16	ppm	
6	TSS	IS 3025 P-17	ppm	
7	Silica	ASTM D 859	ppm	
8	Total Silica as SiO_2	ASTM D 859	ppm	
9	Colloidal SiO_2	ASTM D 859	ppm	
10	Sodium	AAS (PE Application note)	ppm	
11	p-Alkalinity ~~NaOH~~	APHA 2320B	ppm	
12	Iron	APHA-3500 Fe B	ppm	
13	Copper	IS 3025 P-42	ppm	
14	Chloride	IS 3025 P-32	ppm	
15	Total Hardness as $CaCO_3$	IS 3025 P-21	ppm	
16	Total Alkalinity as $CaCO_3$	APHA-2320 B	ppm	
17	Calcium as $CaCO_3$	IS 3025 P-21	ppm	
18	Chloride as Cl^-	IS 3025 P-32	ppm	
19	Magnesium	IS 3025 P-21	ppm	
20	Sulphate	IS 3025 P-24	ppm	
21	Sulphhide	IS 3025 P-29	ppm	
22	Ammonia	IS 3025 P-34	ppm	
23	Residual Chlorine	4500-Cl A	ppm	
24	Free Oil	Can be determined by O & G Analyzer - APHA 5220B	ppm	
25	Phenol	ASTM D1783	ppm	
26	BOD_5	APHA 5210 D / IS 3025 P-44	ppm	
27	Dissolved Oxygen (DO)	ASTM D888	ppm	
28	O-PO4	APHA-4500-P D	ppm	
29	TOC	APHA-5310 B	ppm	

NOTES

1. Fire Water quality would be equivalent to Make up water quality. Make up water may be Raw water, desalinated water from Sea water RO units, or a combination thereof.

~~2. To be confirmed.~~

2. Attachment 2 to BEDD EPCMD-1-DBD-GE-001 dated 20.06.12.

3. Fire water system shall not be charged with sea water. Sea water shall be utilized only during fire suppression and for this purpose a back up connection of sea water shall be provided to fire water Network.

1	20.06.12.	Note 2	SM	SM	SM / KMB
0	21.05.12	Note 2	SB / PS	SM	SM
Rev	**Date**	**Description**	**By**	**Checked**	**Approved**

STEAM QUALITY

Sr.No	Parameters	Testing Method	Unit	Specification
1	pH	IS 3025 P-11	—	8.8 - 9.5
2	Conductivity (Before Cation Resin bed)	ASTM D1125	µ mhos/cm	15 (Max)
3	Silica,as SiO_2	ASTM D 859	ppm	< 0.02
4	Iron, as Fe	APHA-3500 Fe B / ICP	ppm	< 0.02
5	Copper, as Cu	ICP	ppm	<0.005
6	Sodium, as Na	ICP	ppm	< 0.01
7	Potassium , as K	ICP	ppm	<0.0015
8	Chloride	Ion-Chromatography	ppm	< 0.05
9	p-Alkalinity ~~Free OH~~	APHA 2320B	ppm	<0.0001
10	Phosphate , as PO4	ICP	ppm	< 0.01
11	TOC	APHA-5310 B*	ppm	0.5 Max
12	TDS		ppm	

NOTES

1. Quality is Typical for Steam. To be verified during facility design Basis.

~~2. To be confirmed.~~

2. Attachment 2 to BEDD EPCMD-1-DBD-GE-001 dated 20.06.12.

3. Above Specifications may not be applicable for all levels of steam.

* Method detection limit is 1.0 ppm

1	20.06.12.	Note 2	SM	SM	SM / KMB
0	21.05.12	Note 2	SB / PS	SM	SM
Rev	**Date**	**Description**	**By**	**Checked**	**Approved**

CONDENSATE QUALITY				
Sr.No	**Parameters**	**Testing Method**	**Unit**	**Specification (Note-1)**
1	pH	IS 3025 P-11	—	8.3 - 9.0
2	Conductivity	ASTM D1125	µ mhos/cm	6
3	TDS	IS 3025 P-16	ppm w/w	< = 4
4	TSS	IS 3025 P-17	ppm w/w	Nil
5	Silica	ASTM D 859	ppm w/w	0.03
6	Sodium	AAS (PE Application note)	ppm w/w	Nil
7	p-Alkalinity ~~NaOH~~	APHA 2320B	ppm w/w	Nil
8	Iron	APHA-3500 Fe B	ppm w/w	0.03
9	Copper	ICP	ppm w/w	0.02
10	Sulphate	IS 3025 P-24	ppm w/w	Nil
11	Chloride	IS 3025 P-32	ppm w/w	Nil
12	Residual Chlorine	APHA 4500 Cl A	ppm w/w	Nil
13	Total Hardness as $CaCO_3$	IS 3025 P-21	ppm w/w	Nil
14	Total Alkalinity as $CaCO_3$	APHA 2320 B	ppm w/w	Nil
15	Calcium as $CaCO_3$	IS 3025 P-21	ppm w/w	Nil
16	Dissolved Oxygen (DO)	ASTM D888	ppb w/ w	
17	TOC	APHA 5310 B*	ppm w/ w	< 10

NOTES

1. Typical condensate quality will depend upon the BFW quality and Condensate polishing facilities. Values shall evolve as design progresses

~~2. To be confirmed.~~

3. Attachment 2 to BEDD EPCMD-1-DBD-GE-001 dated 20.06.12.

4. The Quality indicated above may not apply to all pressure levels of condensate

* Method detection limit is 1.0 ppm

1	20.06.12.	Note 2	SM	SM	SM / KMB
0	21.05.12	Note 2 ~~3~~	SB / PS	SM	SM
Rev	**Date**	**Description**	**By**	**Checked**	**Approved**

QUALITY OF SYN GAS FROM GASIFICATION UNITS

Sr.No	Parameters	Testing Method	Unit	Specification
	Composition			
1	H20	Portable Dew Point Meter / Draeger tubes / GC		
2	N2	UOP-539		
3	Oxygen	UOP-539		
4	CO	UOP-539		
5	CO2	UOP-539		
6	H2S	ASTM D6228		
7	NH3			
8	H2	UOP-539		
9	C1	UOP-539		
10	C2=	UOP-539		
11	C2	UOP-539		
12	C3=	UOP-539		
13	C3	UOP-539		
14	iC4=	UOP-539		
15	iC4	UOP-539		
16	nC4	UOP-539		
17	=N1C4	UOP-539		
18	=T2C4	UOP-539		
19	=C2C4	UOP-539		
20	=1=4C5	UOP-539		
21	3M=1C4	UOP-539		
22	=1C5	UOP-539		
23	2M=1C4	UOP-539		
24	=T2C5	UOP-539		
25	=C2C5	UOP-539		
26	2M=2C4	UOP-539		
27	iC5	UOP-539		
28	nC5	UOP-539		
29	C6+	UOP-539		
	Total			
30	LHV	ASTM D3588	Kcal/kg	
31	MW	By Calculation		

NOTES

1. OSBL Designer will work out final numbers based on quality numbers advised by process licensor.

2. For Gasification complex, Syngas CO + H_2S content is limited to 20 ppmv. Indicative Fuel gas composition inside Gasification complex is Methane 97.84 mole%; Nitrogen 1.66 Mole%; Total Sulfur 50 mg/SCF; CO_2 : 0.5 Mole %.

3 Deleted

~~4. To be confirmed.~~

4. Attachment 2 to BEDD EPCMD-1-DBD-GE-001 dated 20.06.12.

1	20.06.12.	Note 4	SM	SM	SM / KMB
0	21.05.12	Note 4~~-5~~	SB / PS	SM	SM
Rev	**Date**	**Description**	**By**	**Checked**	**Approved**

QUALITY OF NATURAL GAS FROM GSPL

Sr.No	Parameters	Testing Method	Unit	Specification
	Composition			
1	H20	Portable Dew Point Meter / Draegar tubes / GC		
2	N2	UOP-539		0.2
3	Oxygen	UOP-539		
4	CO	UOP-539		
5	CO2	UOP-539		0.3
6	H2S	ASTM D6228		
7	NH3			
8	H2	UOP-539		
9	C1	UOP-539		98.2
10	C2=	UOP-539		
11	C2	UOP-539		1
12	C3=	UOP-539		
13	C3	UOP-539		0.3
14	iC4=	UOP-539		
15	iC4	UOP-539		
16	nC4	UOP-539		
17	=N1C4	UOP-539		
18	=T2C4	UOP-539		
19	=C2C4	UOP-539		
20	=1=4C5	UOP-539		
21	3M=1C4	UOP-539		
22	=1C5	UOP-539		
23	2M=1C4	UOP-539		
24	=T2C5	UOP-539		
25	=C2C5	UOP-539		
26	2M=2C4	UOP-539		
27	iC5	UOP-539		
28	nC5	UOP-539		
29	C6+	UOP-539		
	Total			100
30	LHV	ASTM D3588	Kcal/kg	11,844
31	MW	By Calculation		16.4

NOTES

1. The composition of Natural gas is typical.

2

3

~~4. To be confirmed.~~

5. Attachment 2 to BEDD EPCMD-1-DBD-GE-001 dated 20.06.12.

1	20.06.12.	Note 5	SM	SM	SM / KMB
0	21.05.12	Note 5	SB / PS	SM	SM
Rev	**Date**	**Description**	**By**	**Checked**	**Approved**

INDICATIVE QUALITY OF RETURN GASES FROM ROGC

Sr.No	Parameters	Testing Method	Unit	Specification
	Composition			
1	H20	Portable Dew Point Meter / Draegar tubes / GC		
2	N2	UOP-539		10.7
3	Oxygen	UOP-539		
4	CO	UOP-539		1
5	CO2	UOP-539		
6	H2S	ASTM D6228		
7	NH3			
8	H2	UOP-539		14.1
9	C1	UOP-539		73.8
10	C2=	UOP-539		
11	C2	UOP-539		0.4
12	C3=	UOP-539		
13	C3	UOP-539		
14	iC4=	UOP-539		
15	iC4	UOP-539		
16	nC4	UOP-539		
17	=N1C4	UOP-539		
18	=T2C4	UOP-539		
19	=C2C4	UOP-539		
20	=1=4C5	UOP-539		
21	3M=1C4	UOP-539		
22	=1C5	UOP-539		
23	2M=1C4	UOP-539		
24	=T2C5	UOP-539		
25	=C2C5	UOP-539		
26	2M=2C4	UOP-539		
27	iC5	UOP-539		
28	nC5	UOP-539		
29	C6+	UOP-539		
	Total			100
30	LHV	ASTM D3588	Kcal/kg	9,764
31	MW	By Calculation		15.5

NOTES

1. ROGC is expected to return a fuel gas stream rich in nitrogen. Suitable tie-in point for that stream will need to be determined without affecting quality of fuel gas (CV ? Wobbe index) at any of the existing consumers.

2

3

~~4. To be confirmed.~~

5. Attachment 2 to BEDD EPCMD-1-DBD-GE-001 dated 20.06.12.

6

1	20.06.12.	Note 5	SM	SM	SM / KMB
0	21.05.12	Note 5	SB / PS	SM	SM
Rev	**Date**	**Description**	**By**	**Checked**	**Approved**

INDICATIVE QUALITY OF SYN GAS

Sr.No	Parameters	Testing Method (Note 2)	Unit	Specification
	Composition			
1	H20	Portable Dew Point Meter / Draegar tubes / GC	mole %	0.1
2	N2	UOP-539	mole %	4.3
3	AR		mole %	1
4	Oxygen	UOP-539		
5	CO	UOP-539	mole %	1
6	CO2	UOP-539		
7	H2S	ASTM D6228		
8	NH3			
9	H2	UOP-539	mole %	13.2
10	C1	UOP-539	mole %	80.4
11	C2=	UOP-539		
12	C2	UOP-539		
13	C3=	UOP-539		
14	C3	UOP-539		
15	iC4=	UOP-539		
16	iC4	UOP-539		
17	nC4	UOP-539		
18	=N1C4	UOP-539		
19	=T2C4	UOP-539		
20	=C2C4	UOP-539		
21	=1=4C5	UOP-539		
22	3M=1C4	UOP-539		
23	=1C5	UOP-539		
24	2M=1C4	UOP-539		
25	=T2C5	UOP-539		
26	=C2C5	UOP-539		
27	2M=2C4	UOP-539		
28	iC5	UOP-539		
29	nC5	UOP-539		
30	C6+	UOP-539		
31	Total			100
32	LHV	ASTM D3588		10,633
33	MW	By Calculation		15.2

NOTES

1. Composition is indicative only. Detail composition to be furnished based on numbers advised by process licensor.

2. To be confirmed.

2. Attachment 2 to BEDD EPCMD-1-DBD-GE-001 dated 20.06.12.

1	20.06.12.	Note 2	SM	SM	SM / KMB
0	21.05.12	Note 2-~~3~~	SB / PS	SM	SM
Rev	**Date**	**Description**	**By**	**Checked**	**Approved**

QUALITY OF FUEL OIL				
Sr.No	**Parameters**	**Testing Method**	**Unit**	**Specification**
1	Viscosity @ supply temp	ASTM D445	cP	< 40
2	Maximum Sulphur	ASTM D4294	wt%	0.25
3	Maximum Nitrogen content	ASTM D4629	ppmw	700
4	Lower Heating value	ASTM D4809	Kcal/Kg	Fuel oil specific

NOTES

1. Typical quality specification for DTA and SEZ refineries. Usage of FO is not foressen for J3 Complex.

~~2. To be confirmed.~~

2. Attachment 2 to BEDD EPCMD-1-DBD-GE-001 dated 20.06.12.

1	20.06.12.	Note 2	SM	SM	SM / KMB
0	21.05.12	Note 2 ~~3~~	SB / PS	SM	SM
Rev	**Date**	**Description**	**By**	**Checked**	**Approved**

QUALITY OF PLANT AIR AND INSTRUMENT AIR

Sr.No	Parameters	Testing Method (Note 2)	Unit	Specification
1	**Plant Air**			
	Oil content		-	Oil Free
	Water saturation		-	Water Saturated
2	**Instrument Air**			
	Oil content		-	Oil Free
	Dew Point@normal supply pressure	Dew Point meter	^{0}C	-40

NOTES

1. Refer separate sheet for breathing air quality.
~~2. To be confirmed.~~
3. Attachment 2 to BEDD EPCMD-1-DBD-GE-001 dated 20.06.12.

Rev	Date	Description	By	Checked	Approved
1	20.06.12.	Note 3	SM	SM	SM / KMB
0	21.05.12	Note 3	SB / PS	SM	SM

QUALITY OF NITROGEN				
Sr.No	**Parameters**	**Testing Method (Note 2)**	**Unit**	**Specification**
1	Nitrogen purity		Vol %	99.99 (min)
2	Oxygen	Teledyne meter	ppmv	< 5 (<10 for gasification)
3	CO_2	UOP -603	ppmv	1 max
4	CO	UOP -603		< 1.0 ppm
5	Oil			Nil
6	Dew Point@atm. Pressure	Dew point Meter	^oC	- 100

NOTES

1. Typical Nitrogen quality specification.
2. To be confirmed.
3. Attachment 2 to BEDD EPCMD-1-DBD-GE-001 dated 20.06.12
4. The ASUs for gasification supply HP and LP nitrogen to gasification complex with 98% Nitrogen, 2% Argon and <10 ppm Oxygen.

1	20.06.12.	Note 3	SM	SM	SM / KMB
0	21.05.12	Note 3	SB / PS	SM	SM
Rev	**Date**	**Description**	**By**	**Checked**	**Approved**

ELECTRIC SUPPLY PARAMETERS			
Sr.No	**Parameters**	**Unit**	**Specification**
A	**Supply tolerances**		
I	Steady State Limits		
1	**Non UPS**		
	Voltage		+/- 10 %
	Frequency		+/- 5 %
2	**UPS**		
	Voltage		+6 / -1 % (at equipment)
	Frequency		+/- 1 % feed via inverter +/- 5 % feed via bypass transformer
II	Transient Limits		
	Non UPS		
	Voltage		+/- 20 %
	Frequency		+/- 5 %
III	DC Voltage Tolerance		+/- 10 % , -15 %

NOTES

1 Indicative parameters. May further evolve as design progresses.

2. Attachment 2 to BEDD EPCMD-1-DBD-GE-001 dated 20.06.12.

1	20.06.12.	Note 2	SM	SM	SM / KMB
0	21.05.12	Note 2	SB / PS	SM	SM
Rev	**Date**	**Description**	**By**	**Checked**	**Approved**

QUALITY OF BREATHING AIR

Sr.No	Parameters	Testing Method (Note 2)	Unit	Specification
1				
	Oil content		-	Oil Free
	Water saturation		-	Water Saturated
2	**Instrument Air**			
	Oil content		-	Oil Free
	Dew Point@normal supply pressure	Dew Point meter	^0C	-40
3	**Breathing Air**			

NOTES

1. For further details on breathing air quality - refer to - RIL Group Standard - Respiratory Protective Equipment.

~~2. To be confirmed.~~

3. Attachment 2 to BEDD EPCMD-1-DBD-GE-001 dated 20.06.12.

1	20.06.12.	Note 3	SM	SM	SM / PT
0	21.05.12	Note 3	SB / PS	SM	SM
Rev	**Date**	**Description**	**By**	**Checked**	**Approved**

QUALITY OF POTABLE WATER (RIL CORPORATE STANDARD GUIDELINE)				
Sr.No	**Parameters**	**Testing Method**	**Unit**	**Specification (as per IS 10500 : 1991)**
1	Normal Supply temperature	IS 3025 P-9	°C	
2	pH	IS 3025 P-11	—	6.5 - 8.5 (no relaxation)
3				
4	Turbidity	IS 3025 P-10	NTU	
5	TDS	IS 3025 P-16	ppm	500 Maximum 2000
6	TSS	IS 3025 P-17	ppm	
7	Silica	ASTM D 859	ppm	
8	Total Silica as SiO_2	ASTM D 859	ppm	
9	Colloidal SiO_2	ASTM D 859	ppm	
10	Mercury		ppm	
11	Cadmium		ppm	
12	Selenium		ppm	
13	Arsenic		ppm	
14	Cyanide		ppm	
15	Lead		ppm	
16	Chromium		ppm	
17	Iron as Fe	APHA-3500 Fe B	ppm	0.3 Maxm 1
16	Total Alkalinity as $CaCO_3$	APHA-2320 B	ppm	
18	Calcium as $CaCO_3$	IS 3025 P-21	ppm	300, maximum 600
19	Chloride as Cl^-	IS 3025 P-32	ppm	250 Maxm 1000
20	Magnesium	IS 3025 P-21	ppm	
20	Sulphate	IS 3025 P-24	ppm	
21	Sulphhide	IS 3025 P-29	ppm	
22	Ammonia	IS 3025 P-34	ppm	
23	Residual Chlorine	4500-Cl A	ppm	
24	Free Oil	Can be determined by O & G Analyzer - APHA 5220B	ppm	
25	Phenol	ASTM D1783	ppm	
26	BOD_5	APHA 5210 D / IS 3025 P-44	ppm	
27	Dissolved Oxygen (DO)	ASTM D888	ppm	
28	O-PO4	APHA-4500-P D	ppm	
29	TOC	APHA-5310 B	ppm	

NOTES

1. For further details refer to RIL-HSE-1.2-05.07 Rev 0.

~~2. To be confirmed.~~

2. Attachment 2 to BEDD EPCMD-1-DBD-GE-001 dated 20.06.12

1	20.06.12.	Note 2	SM	SM	SM / PT
0	21.05.12	Note 2 ~~3~~	SB / PS	SM	SM
Rev	**Date**	**Description**	**By**	**Checked**	**Approved**

ATTACHMENT 3 - Utilities Battery Limit Conditions

UTILITIES BATTERY LIMIT CONDITIONS

ATTACHMENT 3

TO

EPCMD-1-DBD-GE-001

BEDD FOR J3 PROJECTS

RELIANCE

Notes

1. Preliminary battery limit information available from various process units have been studied. The numbers in this document, though preliminary, do not appear to have disconnects with process unit requirements.

2. The numbers reported are mostly actual plant typical numbers from DTA and SEZ refineries, that have got established due to a) source conditions as indicated and b) existing distribution networks in the refineries. OSBL designer shall ensure that these numbers are satisfied for J3. Changes will be made only where inevitable, with the concurrence of RIL.

3. Where no number has been provided in current revision, OSBL Designer shall populate the tables as design evolves.

Rev	Date	Description	By	Checked	Approved
1	20.06.2012	Revised and updated	SM	SM	SM / KMB
0	21.05.2012	Issued for Licensor KOM	SB/ PS	SM	SM

RAW WATER BATTERY LIMIT CONDITIONS								
Description	Pressure (Kg/Cm^{2}g) (Typical)				Temperature (^{o}C)			
	Min	Normal	Max	Design	Min	Normal	Max	Design
Raw water to Cooling Tower	3.5	4	6.5	7	Amb	Amb	Amb	65
Raw water to Utility Water	3.5	4	6.5	7	Amb	Amb	Amb	65
Raw water to any other application	3.5	4	6.5	7	Amb	Amb	Amb	65

NOTES :

1. Raw Water will be sourced from RO Desalinated water units installed in J3 complex.

2. Attachment 3 to BEDD EPCMD-1-DBD-GE-001 dated 20.06.12.

3. The pressure at source will depend on the tie-in point and the conditions there. Suitable pumping facility will need to be arranged to meet the requirements at the destinations points. Exact battery limit conditions will be firmed up during facility design.

1	20.06.12.	Note 2	SM	SM	SM / KMB
0	21.05.12	Note 2	SB/PS	SM	SM
Rev No	Date	Description	By	Checked	Approved

SEA WATER BATTERY LIMIT CONDITIONS

Description	Pressure (Kg/Cm^{2}g)				Temperature (^{o}C)			
	Min	Normal	Max	Design	Min	Normal	Max	Design
Sea water to Desalination Plant								
Sea Water to Sea water Cooling tower								
Sea Water to MTF Fire water System								
Sea water return from Desalination plant								
Sea Water return / blowdown from SW CT								

NOTES :

1. From sea water intake, sea water will be pumped, filtered and delivered to the consumers, Desalination plants, Sea water cooling tower (if any), and back-up supply to Fire water (during actual fire-fighting only), at Marine Terminal.

2. Attachment 3 to BEDD EPCMD-1-DBD-GE-001 dated 20.06.12.

3. The level of integration with existing facilities at DTA and SEZ refineries and will depend on the total water requirement. Where new facilities will need to be installed, the operating and design conditions shall depend on requirements at destinations, geographic locations of intake system, line routings and any specific system constraints. Exact numbers will evolve during progress of design.

4 The return header conditions will depend on the level of integration with existing facility, new outfall point location, depth of submergence at point of discharge and design of diffuser.

1	20.06.12.	Note 2	SM	SM	SM / KMB
0	21.05.12	Note 2	SB/PS	SM	SM / KMB
Rev No	Date	Description	By	Checked	Approved

DESALINATED WATER BATTERY LIMIT CONDITIONS								
Description	Pressure (Kg/Cm^{2}g)				Temperature (^{o}C)			
	Min	Normal	Max	Design	Min	Normal	Max	Design
At Demineralised water system								
At Utility / Potable Water System								
At Fire Water System								
At Cooling Tower								

NOTES :

1. Desalinated Water from existing Desalination units and new RO units in J3 will be stored in tanks and then pumped to the consumers, Demineralised Plant (from existing Desalination units), Utility/Potable Water System, Cooling tower, and back-up supply to Fire water.

2. Attachment 3 to BEDD EPCMD-1-DBD-GE-001 dated 20.06.12.

3. The level of integration with existing facilities at DTA and SEZ refineries will depend on the total water requirement. Where new facilities will need to be installed, the operating and design conditions shall depend on requirements at destinations, geographic locations of new Desal units, Desal water tanks and final locations of consumers, line routings and any specific system constraints. Exact numbers will evolve during progress of design.

1	20.06.12.	Note 2	SM	SM	SM / KMB
0	21.05.12	Note 2	SB/PS	SM	SM / KMB
Rev No	Date	Description	By	Checked	Approved

COOLING WATER BATTERY LIMIT CONDITIONS

Description	Pressure (Kg/Cm^2g) (Note 6)			Temperature (^oC) (Note 6)			
	Supply (Note 2)	Return (Note -2)	Water side (Heat Exchanger) Design Pressure	Supply	Return (Average)	Max outlet Temperature of Exchanger	Water side (Heat Exchanger) Design Temperature
Fresh Cooling Water system	4.1/ 4.6	Note 6	7 / F.V.	32	45	49	120

NOTES :

1. Battery limit conditions indicate typical figures for Cooling towers in DTA and SEZ refineries installations in Jamnagar.
2 Minimum at any process battery limit , grade level
3. If supply pressure required for a specific unit is different from usual values , then same shall be specified
4. Attachment 3 to BEDD EPCMD-1-DBD-GE-001 dated 20.06.12.
5. Number of towers and the process units / utilities blocks these will serve will depend on overall plot plan and geographic spread. Tower to tower, there can be small variations in terminal design conditions. Will be finalised as design progresses.

6. In DTA and SEZ refineries, the cooling water supply pressure at source is 5.1 kg/cm^2g and temperature is 32 ^0C. Cooling water return Pressure and temperature at Unit battery limit is 2.8 Kg/cm^2g and 45 ^0C respectively. The Pressure at grade near cooling tower must be sufficient for water to rise to Cooling tower nozzle.

1	20.06.12	Note 4	PS	SM	SM / KMB
0	21.05.12	Note 4	SB/PS	SM	SM
Rev No	Date	Description	By	Checked	Approved

COOLING TOWER MAKE-UP WATER BATTERY LIMIT CONDITIONS

Description	Pressure (Kg/Cm^{2}g)				Temperature (^{o}C)			
	Min	Normal	Max	Design	Min	Normal	Max	Design
Make up from Sea water								
Make up from treated effluent Low Total Dissolved Solids water (LTDS)								
Make up from treated effluent High Total Dissolved Water (HTDS)								
Make up from return Condensate								

NOTES :

1. The sources for make-up to each cooling tower will be firmed up during facility design.
2. Attachment 3 to BEDD EPCMD-1-DBD-GE-001 dated 20.06.12.
3. Low Total Dissolved Solids Water is indicated based on experience in DTA and SEZ refinery complexes. For the J3 complex, the quality of effluent water will evolve as process design progresses and water circuits are analysed and configured for zero discharge.
3. High Total Dissolved Solids Water is indicated based on experience in DTA and SEZ refinery complexes. For the J3 complex, the quality of effluent water will evolve as process design progresses and water circuits are analysed and configured for zero discharge.

1	20.06.12.	Note 2	SM	SM	SM / KMB
0	21.05.12	Note 2	SB / PS	SM	SM
Rev No	Date	Description	By	Checked	Approved

DEMINERALIZED WATER BATTERY LIMIT CONDITIONS

Description	Pressure (Kg/Cm^{2}g)				Temperature (^{o}C)			
	Min	Normal	Max	Design	Min	Normal	Max	Design
Demineralised Water	6.5	7	7.5	10	Amb	Amb	Amb	65

NOTES :

1. Based on current Installation at Jamnagar. To be verified during facility design.
2. Attachment 3 to BEDD EPCMD-1-DBD-GE-001 dated 19.06.12.

1	19.06.12.	Note 2	SM	SM	SM / KMB
0	21.05.12	Note 2	SB / PS	SM	SM
Rev No	Date	Description	By	Checked	Approved

BOILER FEED WATER BATTERY LIMIT CONDITIONS				
Description	Pressure (Kg/Cm^{2}g)		Temperature (^{o}C)	
	Normal (Note 3 & 4)	Design	Normal	Design
HHP BFW	127.7 (Note 5)	163.2 (Note 5)	121	150
HP BFW	59.2	78	121	150
MP BFW	23.9	33.8	121	150
LP BFW	10.9	17.6	121	150

NOTES :

1. Based on current Installation at Jamnagar. To be verified during facility design.
2. Attachment 3 to BEDD EPCMD-1-DBD-GE-001 dated 20.06.12.
3. In DTA refinery, the pressure at source for HHP, HP, MP and LP boiler feed water is 127.7, 68 , 28 and 14.7 kg/cm^{2}g respectively. Pressure at destination is dependent on distribution network.
4. In SEZ refinery, the pressure at source for HP, MP and LP boiler feed water is 75 , 30 and 14.7 kg/cm^{2}g respectively. Pressure at destination is dependent on distribution network.
5. The HHP BFW network operating and design pressure will depend on the distance from process HHP generators in Gasification and ROGC Complex and mode of integration with DTA refinery HHP BFW network, if any.

1	20.06.12	Note 2	SM	SM	SM / KMB
0	21.05.12	Note 2	SB / PS	SM	SM
Rev No	Date	Description	By	Checked	Approved

POTABLE WATER BATTERY LIMIT CONDITIONS								
Description	**Pressure (Kg/Cm^{2}g)**				**Temperature (^{o}C)**			
	Normal @ Source	**Normal @ Process Battery limit**	**Normal @ User**	**Design**	**Min**	**Normal**	**Max**	**Design**
Potable Water	3.8	3.5	3	7	3	35	43	65

NOTES :

1. Based on current Installation at Jamnagar. To be verified during facility design.
2. Attachment 3 to BEDD EPCMD-1-DBD-GE-001 dated 20.06.12.

1	20.06.12.	Note 2	SM	SM	SM / KMB
0	21.05.12	Note 2	SB / PS	SM	SM
Rev No	Date	Description	By	Checked	Approved

FIRE WATER BATTERY LIMIT CONDITIONS							
Description	Pressure (Kg/Cm^2g) (Note-2)			Temperature (^oC)			
	Min	Max	Design	Min	Normal	Max	Design
Fire Water system	7 (Note -3)	15	16.2	3	35	43	65

NOTES :

1. Based on current Installation at Jamnagar. To be verified during facility design.
2. At process battery limits, grade level.
3. At the farthest point from pumps.
4. Attachment 3 to BEDD EPCMD-1-DBD-GE-001 dated 20.06.12.

1	20.06.12.	Note 4	SM	SM	SM / KMB
0	21.05.12	Note 4	SB / PS	SM	SM
Rev No	Date	Description	By	Checked	Approved

STEAM BATTERY LIMIT CONDITIONS

Description	Pressure (Kg/Cm^{2}g)				Temperature (^{o}C)			
	Min	Normal	Max	Design	Min	Normal	Max	Design
HHP Steam	101	106	109	117	490	510	515	540
HP Steam	40.1	42.2	43.2	47.6	381	383	399	426
MP Steam	15	16	17.2	21.1	201	232	260	288
LP Steam	3.5	4.1	4.6	8.1	147	158	232	260
Steam Blowdown	See Note-2							

NOTES :

1. For reference, from current installation at Jamnagar.

A. In DTA refinery, the HHP, HP, MP and LP steam conditions at CPP are :

HHP : 110 kg/cm^{2}g and 510 ^{0}C , HP : 42.2 kg/cm^{2}g and 383 ^{0}C, MP : 17 Kg/cm^{2}g and 240 ^{0}C, LP : 4.1 kg/cm^{2}g and 158 ^{0}C. The pressure and temperature at user battery limit is to be met.

B. In SEZ refinery, the HP, MP and LP steam conditions at CPP are :

HP : 43 kg/cm^{2}g and 390 ^{0}C, MP : 17 Kg/cm^{2}g and 260 ^{0}C, LP : 4.1 kg/cm^{2}g and 158 ^{0}C. The pressure and temperature at user battery limit is dependent on distribution network, connected generators and Steam turbines.

2. As per conditions of condensate type from which steam blowdown originates.
3. Steam drivers and ejectors must be able to operate at minimum conditions.
4. Attachment 3 to BEDD EPCMD-1-DBD-GE-001 dated 20.06.12

1	20.06.12	Note 4	SM	SM	SM / KMB
0	21.05.12	Note 4	SB/PS	SM	SM
Rev No	Date	Description	By	Checked	Approved

CONDENSATE BATTERY LIMIT CONDITIONS								
Description	**Pressure (Kg/Cm^{2}g)**				**Temperature (^{o}C)**			
	Min	**Normal**	**Max**	**Design**	**Min**	**Normal**	**Max**	**Design**
HP Condensate	41.1	42.2	43.2	47.6	252	254	255	261
MP Condensate	15	16	17	21.1	201	203	206	217
LP Condensate	3.5	4.1	4.6	8.1	147*	152*	154*	175*

NOTES :

1. Based on current installation at Jamnagar. To be verified during facility design.
2. Condensate pressures represent the pressure at grade.
3. *All condensate temperatures are saturation temperatures at corresponding pressure. Post stabilization at atmospheric pressure, temperature will be limited to 100 degree C.
4. Attachment 3 to BEDD EPCMD-1-DBD-GE-001 dated 20.6.12.

1	20.06.12.	Note 4	SM	SM	SM / KMB
0	21.05.12	Note 4	SB/PS	SM	SM
Rev No	Date	Description	By	Checked	Approved

FUEL GAS BATTERY LIMIT CONDITIONS								
Description	Pressure (Kg/Cm^{2}g)				Temperature (^{o}C)			
	Min	Normal	Max	Design	Min	Normal	Max	Design
Fuel Gas (Note 1)	3.2	3.9	4.6	6.5	38	38	94	120
Natural Gas @ intake								
Natural gas @ CPP								
PSA tail Gas (Note 2)								
Syn Gas@GTG		25				100		
Syn Gas@HRSGs/aux Boilers		6			20		45	

NOTES :

1. Based on current installation at Jamnagar. To be verified during facility design.
2. PSA Tail gas Pressure at min 2 kg/cm^{2}g. To be used as a fuel Gas to Steam Superheater/aux Boiler. For GTG, pressure to suit vendor's requirements.
3. Attachment 3 to BEDD EPCMD-1-DBD-GE-001 dated 20.06.12.
4. Information related to Syn Gas is furnished based on latest available information.
5. ROGC internal fuel gas quality is being worked for selected licenosr and will be reported as numbers crystallize.
6. ROGC is expected to return a fuel gas stream rich in nitrogen. Suitable tie-in point for that stream will need to be determined without affecting quality of fuel gas (CV ? Wobbe index) at any of the existing consumers.
7. NG system battery limit pressures will be worked out based on GSPCL skid outlet and line drops to J3 consumers. May integrate with existing lines?

1	20.06.12.	Note 3	SM	SM	SM / KMB
0	21.05.12	Note 3	SB / PS	SM	SM
Rev No	Date	Description	By	Checked	Approved

FUEL OIL BATTERY LIMIT CONDITIONS								
Description	Pressure (Kg/Cm^{2}g)				Temperature (^{o}C)			
	Min	Normal	Max	Design	Min	Normal	Max	Design
Supply Header	10	11	12	21	55	66	88	110
Return Header	2	4	4.5	21	55	66	88	110

NOTES :

1. Based on current installation at Jamnagar. As of now, FO system is not foreseen in J3 projects.
2. Attachment 3 to BEDD EPCMD-1-DBD-GE-001 dated 20.06.12

1	20.06.12.	Note 2	SM	SM	SM / KMB
0	21.05.12	Note 2	SB / PS	SM	SM
Rev No	Date	Description	By	Checked	Approved

PLANT AIR, BREATHING AIR AND INSTRUMENT AIR BATTERY LIMIT CONDITIONS

Description	Pressure (Kg/Cm^2g) (Note 4 & 5)				Temperature (^oC) (Note 4 & 5)		
	Min	Normal	Max	Design	Min	Normal	Design
Plant Air	5	7.7	8.5	10	10	40	65
Breathing Air	6	9.1		10	40	40	65
Instrument Air(Note 3)	6	7	8	10	40	40	65

NOTES :

1. Based on current installation at Jamnagar. To be verified during facility design.
2. Attachment 3 to BEDD EPCMD-1-DBD-GE-001 dated 20.06.12.
3. For isolation valve actuator sizing use 4.5 Kg/cm^2g.(See also EPCMD-1-ENGG-DBD-CI-001)
4. In DTA refinery, the Pressure and temperature at source are
   Plant Air : 8.1 / 6.7 kg/cm^2g and 32 ^0C , Instrument Air : 8.7 kg/cm^2g and 32 ^0C . The Pressure at user battery limit is dependent on distribution network.
5. In SEZ refinery , the Pressure and temperature at source are
   Plant Air : 7.8 kg/cm^2g and 32 ^0C , Instrument Air : 8.7 kg/cm^2g and 32 ^0C. The Pressure at user battery limit is dependent on distribution network.

1	20.06.12	Note 2	SM	SM	SM / KMB
0	21.05.12	Note 2	SB / PS	SM	SM
Rev No	Date	Description	By	Checked	Approved

NITROGEN SYSTEM BATTERY LIMIT CONDITIONS

Description	Pressure (Kg/Cm^{2}g)				Temperature (^{o}C)			
	Min	Normal (note 6)	Max	Design	Min	Normal	Max	Design
High Pressure Nitrogen(Note 3)	13	13.7		15.4		38	43	65
Low Pressure Nitrogen	6.5	7	8	10.5		38	43	65
LLP Nitrogen (Note 5)		4				Amb		
Medium Pressure Dilute Nitrogen (Note 4 and 5)		25				TBD		

NOTES :

1. Based on current installation at Jamnagar. To be ensured during facility design of J3 by OSBL Designer.
2. Attachment 3 to BEDD EPCMD-1-DBD-GE-001 dated 20.06.12.
3. HP Nitrogen Battery Limit Conditions to be firmed up based on requirements for J3 Units.
4. Required for Both DTA and SEZ refineries
5. Gasification ASUs will be major sources of nitrogen. LLP and MPDGAN details are based on ASU data.
6. In DTA and SEZ refineries, pressure at source for LP nitrogen is 7.3 kg/cm^{2}g and temperature is 32 ^{0}C

1	20.06.12	Note 2	PS	SM	SM / KMB
0	21.05.12	Note 2	SB / PS	SM	SM
Rev No	Date	Description	By	Checked	Approved

ELECTRICITY BATTERY LIMIT CONDITIONS

Description	Voltage	Frequency(Hz)	Phase	Earthing
HT Level	6.6 kV	50	3	neutral low resistance earthed
LT Level	415 V	50	3	neutral solidly earthed
Electrical Control Supply	240 V	50	single	neutral solidly earthed
Small Power and lighting supply	240 V	50	single	neutral solidly earthed
UPS Level	110 V	50	single	one pole solidly earthed
Switchgear (circuit Breaker control)	220 V DC			

NOTES :

1. Attachment 3 to BEDD EPCMD-1-DBD-GE-001 dated 20.06.12
2. See also Electrical Design Basis EPCMD-1-ENGG-DBD-EL-001.

1	20.06.122	Note 1	PS	SM	SM / KMB
0	21.05.12	Note 1	PS	SM	SM
Rev No	Date	Description	BY	Checked	Approved